May 23, 1911.

MAY 24 1911

POWER

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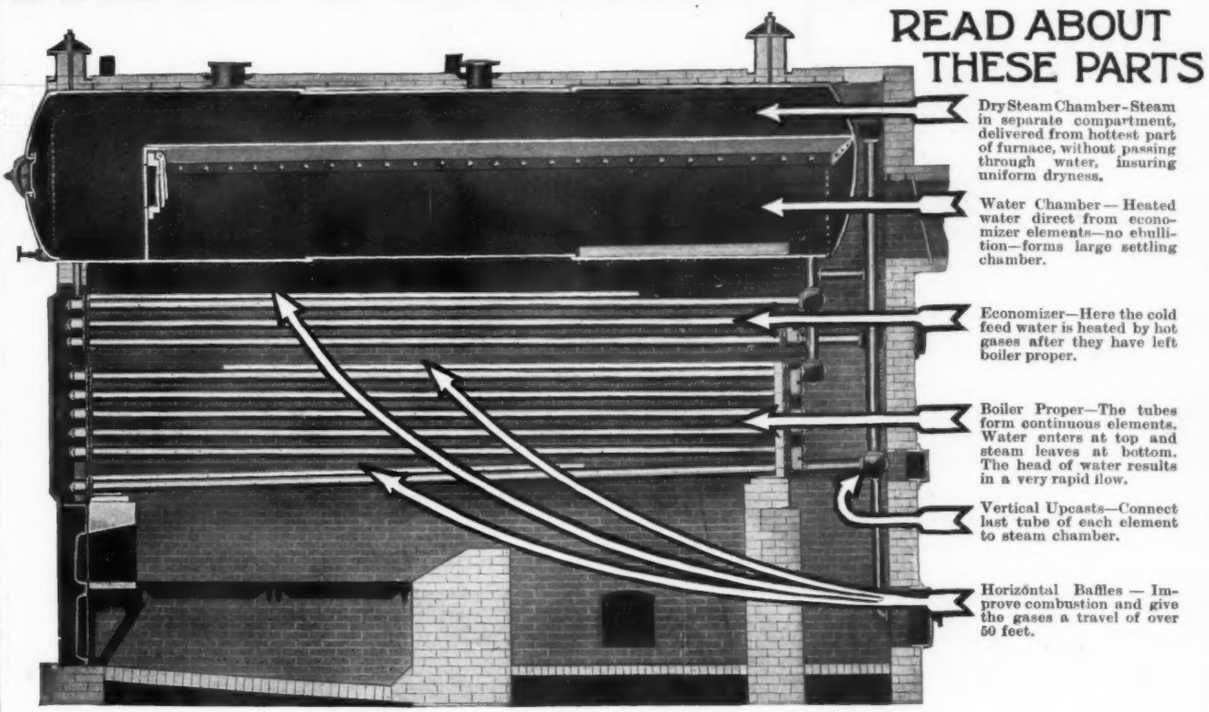
Here's a PARKER BOILER

READ ABOUT THESE PARTS


Dry Steam Chamber—Steam in separate compartment, delivered from hottest part of furnace, without passing through water, insuring uniform dryness.
Water Chamber—Heated water direct from economizer elements—no ebullition—forms large settling chamber.
Economizer—Here the cold feed water is heated by hot gases after they have left boiler proper.
Boiler Proper—The tubes form continuous elements. Water enters at top and steam leaves at bottom. The head of water results in a very rapid flow.
Vertical Upcasts—Connect last tube of each element to steam chamber.
Horizontal Baffles—Improve combustion and give the gases a travel of over 50 feet.

If steam users realized the great difference in efficiency between various boiler designs, they would be more apt to compare the actual principles back of each construction.

That's what we tell you above—the principles back of this Parker Downflow Boiler that enable it to save 10% of your coal bills. Read the following figures:

The cost of coal per boiler H. P. year ranges from $25.00 to $50.00. Ten per cent. saving in coal means from $2.50 to $5.00 per H. P. year. In a plant of 100 H. P. this means a saving of $250.00 to $500.00 a year. On 1000 H. P. the saving amounts to $2500 to $5000 a year.

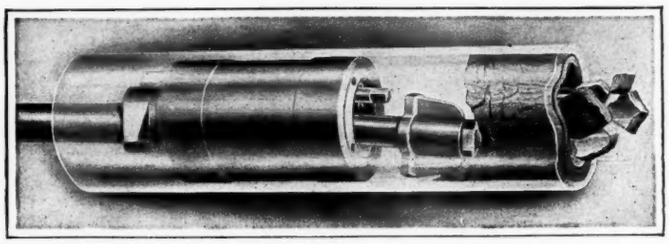
Boilers cost ready for steaming from $10.00 to $20.00 per H. P. Suppose a boiler costing $15.00 per H. P. saves $3.00 per H. P. year in coal over a cheaper boiler. How much is the cheaper boiler worth?

And an economical boiler is a *growing* investment, as coal is not going to be any cheaper.

Talk this boiler question over with us. Let us place a Parker Downflow Boiler alongside of the one you are now using, and we'll guarantee you a big saving. Write to us today for our catalog and booklet of testimonials. Find out all about this Parker Boiler and what it is doing for others. *Write now.*

Parker Boiler Company

1005 Pennsylvania Building **Philadelphia, Pa.**



The Dean Removing Scale from the Tube of a Water Tube Boiler.

Where Investigation Proves Profitable

Don't refuse to consider the Dean because you are using a boiler compound.

That may be a costly mistake.

Find out whether the compound is *removing old* scale or *preventing new* scale from forming.

The Dean will do this for you.

Just run it through your tubes and ten to one you'll remove an astonishing amount of scale.

We can refer you to numerous cases where

The Dean Boiler Tube Cleaner

removed from 200 to 800 pounds of scale from a compound cleaned boiler.

The *compound theory* is extremely attractive, but somehow or other it doesn't seem to make good in actual practice.

Don't take our word for this—investigate and find out.

There's a Dean here for you—write for it.

Try it in one boiler, free of charge, and without incurring any obligations to purchase it.

If you find that your compound is doing the work, well and good.

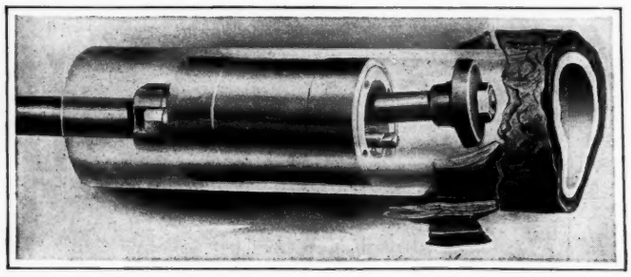
If you find that it is not, the knowledge gained by the test of the Dean will be worth many dollars to you.

Write for "Scale Removal Made Easy" anyway.

The Wm. B. Pierce Company

CHICAGO OFFICE
801 Steinway Building

Jewett Bldg., Buffalo, N. Y.



The Dean Removing Scale from the Tube of a Return Tubular Boiler.

POWER

NEW YORK, MAY 23, 1911

ON several occasions this page has been devoted to attempts to impress upon the engineer the necessity for keeping complete operating and cost records.

If our preaching has borne some fruit, we are gratified, but we do not intend to stop at that; we intend to keep right on as long as there is a chance of getting converts to the cause.

Complete records serve a twofold purpose: they show wherein improvements can be made, and they represent the facts in *black* and *white* by which the engineer can disprove the claims of the central-station solicitor.

If it is found to be costing more to generate power than it should, then there is something wrong with the equipment or the operation; otherwise the class of service is such as to legitimately belong to the central-station field. Whatever the cause the records show where it is located, and the owner knows exactly where he stands.

While assuming this attitude, we are not insensible to the fact that many engineers are seriously handicapped through lack of the proper facilities for making and keeping complete plant records. This is strikingly shown in the following incident, which is perhaps typical of many others—

The engineer of a small plant put in a requisition for a recording wattmeter, and in the course of a few days was summoned to the manager's office. Upon entering he was greeted with the following remark:

"What is the meaning of this requisition? The company has spent $15,000 to install this plant, which is thoroughly uptodate, and we do not propose to spend any additional money on a lot of frills. If you cannot get results with the plant as it is, we shall be compelled to find someone who can."

The question naturally arises—what can an engineer do under such circumstances? Obviously, the answer will depend largely upon the personality and the resourcefulness of the engineer.

Had a consulting engineer made this recommendation, the chances are ten to one that it would have been accepted without being questioned.

Why, then, was not the operating engineer equally successful in his dealings with the manager?

It is because the consulting engineers, as a class, have gained a certain prestige with their clients. A similar prestige belongs to the operating engineer. It is within his reach and he can gain it by taking advantage of his opportunities.

Again, there are many plants not supplied with measuring instruments, upon which the central station is looking with eager eyes. In most cases the central station is anxious to put its own instruments upon the boards of such plants, in order to be in a position to offer an attractive rate.

In such cases, the engineer, if he is making good, should have no hesitation in granting them permission to install the instruments; in fact, he should welcome it, as it affords him an opportunity to know what his plant is doing. Of course, he should take his own readings and be sure of the constants of the meter. With these data he can figure for himself the cost of producing electrical energy.

Novel Method of Supporting Stack

By Cadwalder Evans, Jr. *

When it was decided to increase the hight of the steel stack of the Stevenson building in Pittsburg, it was found that the corner column of the building would not support the additional weight; hence a steel tower was constructed and the new section of stack supported from it on a cantilever.

*Superintendent of central power plant of Oliver estate.

There has recently been completed for the central power plant of the Oliver estate at Pittsburg, a difficult engineering feat in an addition to the smokestack, as shown in the accompanying illustrations. This plant supplies all of the Oliver properties, including the Oliver building, a 25-story office structure, the McCreery & Co. store, a 12-story building, and a number of smaller buildings, with electric lights, steam heat, elevator service, refrigeration and compressed air, and is large enough to take care of any addition which may be made to the property, including the projected Hotel Oliver.

The plant is located in the basemenqt of the Stevenson building annex, and contains 3220 boiler horsepower. As originally constructed, the stack was a self-supporting steel structure 10 feet 6¾ inches outside diameter, rising through one corner of the building to a hight of over 221 feet above the boiler-room floor and 80 feet above the roof of .he building, terminating approximately on a level with the fifteenth floor of the Oliver building, from which it is distant about 200 feet.

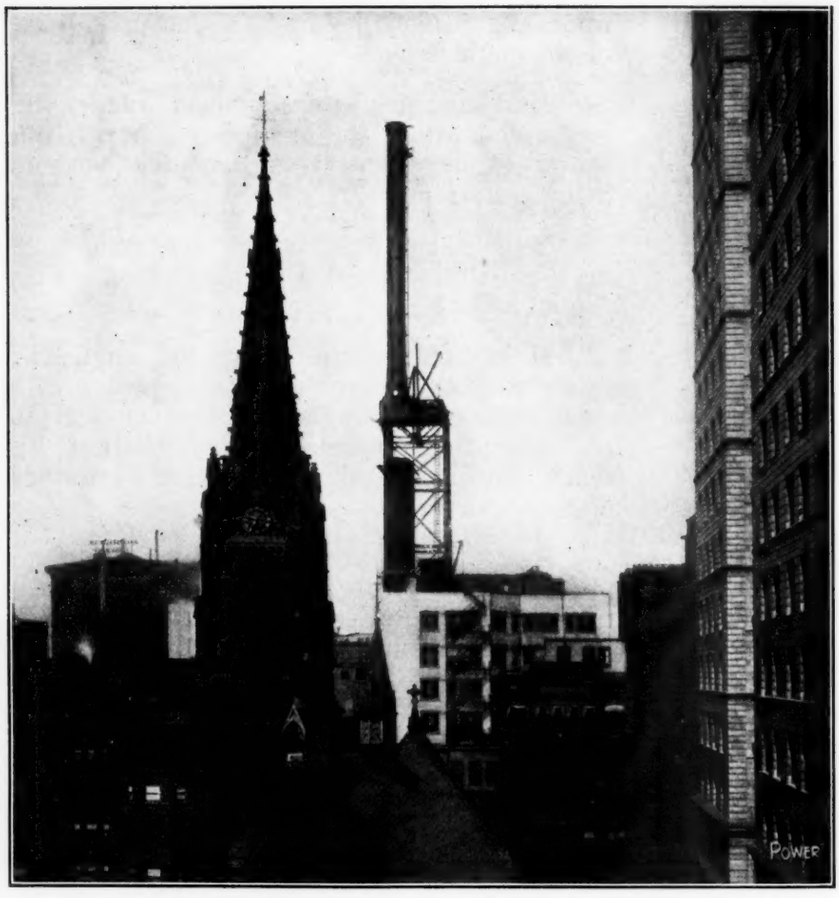


FIG. 1. NEW STACK IN PLACE WITH 18-FOOT SECTION OF OLD STACK REMOVED

The gases from the stack caused considerable discomfort to the tenants above the eighteenth floor in the Oliver building; hence, it was decided to raise the stack. The first plan called for a symmetrical steel tower about the present stack but it was found that the corner column of the building was not heavy enough to carry the load, so the present overhung structure was decided upon. This consists of a steel tower 83 feet 9 inches high supported on four of the building columns and carrying the new stack on a cantilever. The tower is 25 feet 4 inches by 21 feet 5 inches in section and the center of the new stack overhangs the tower by over 6 feet. The new part of the stack is 124 feet high, making the total hight of 345 feet 8⅝ inches above the boiler-room floor and 323 feet 8⅝ inches above the ground.

The new stack is entirely self-supporting, is lined with vitrabestos 2 inches thick and has an inside diameter of 7 feet 8 inches, which is 2 feet 6 inches smaller than the old part. The details of erection were very ingenious and comprised: First, the erection of the steel tower to its total hight, which brought it 6 feet above the top of the old stack; second, an 18-foot section of the old stack was removed and lowered to the ground, complete with its lining; third, a smoke-tight 12x12-foot wooden box with side walls 8 feet high and open at the top, was erected 14 feet above the reduced stack. This afforded a shield from the smoke in which the men were able to work while putting up the lower sections of the new stack. After this was completed, the temporary box was removed and most of the smoke was drawn through the 18-foot open gap. The top section of the old stack was then hoisted back into place in one piece and the extension joint between the old and the new sections was packed, thus completing the job.

FIG. 2. TOWER IN PROCESS OF CONSTRUCTION

Real Cause of a Flywheel Explosion

By Hubert E. Collins

In 1907 the flywheel of a high-speed engine in the Hotel Knickerbocker, New York City, burst and caused considerable property damage. Facts were withheld at the time but information brought out in the preparation of a damage suit led to the conclusion that a dry link pin bound the governor and the engine ran away.

On March 1, 1907, at about 4 p.m., the flywheel burst on No. 3 engine in the Hotel Knickerbocker, New York City. The explosion of this wheel caused considerable property damage, and a barber was quite badly injured by a piece of the wheel coming through the floor of the barber shop where he was sitting in a chair. The fragment of the wheel passed so close to the barber that he lost his balance and fell through the opening in the floor into the engine room below.

Steam pipes were broken and the engine-room force performed acts of valor in stopping the havoc caused by the explosion.

An account of the accident, which was necessarily brief, as all information was refused, appeared in POWER at the time. The facts as here stated were brought out in the preparation of the damage suit of Dominicis versus Astor and Reegan. Dominicis is the name of the injured barber; Astor, the owner of the property, and Reegan, the lessee.

The same day the accident occurred, experts were called in to learn the cause of the accident, and found the governor wheel wrecked, which was the principal damage to the engine.

When the fragments were put together, it was found that one of them in the fracture had uncovered a flaw which appeared as in Fig. 1. This flaw extended around the rim for a distance of about two feet, gradually dwindling down to nothing from the proportionate size shown.

When the parts were reassembled, the wheel had the appearance indicated in Fig. 2. This sketch shows the location of all the fractures, and, of course, the moving parts of the governor and eccentric were stripped from the wheel. One of the stops for the weight arms was broken off.

Joint *B* was completely disrupted, one flange being broken into four pieces and the other one being cracked from the bolt holes out. On this joint one bolt was sheared on one end, one had both ends broken off, and one bolt was intact. There were three bolts to each joint, which were machined in the body 2¼ inches to fit drilled holes in the flanges. The flaw began at the point indicated in Fig. 2 just below the flange of joint *B*.

It was contended by some that the flaw was the primary cause of the accident and this was given first consideration. The principal dimensions of the wheel were as follows: Outside diameter, 90 inches = 7.5 feet; mean diameter, 86.5 inches = 7.2 feet; revolutions per minute rating, 180; rim velocity in feet per minute, 4241; rim velocity in feet per second, 70.6; cross-sectional area of rim, 87 square inches; cross-sectional area of flaw, 3.8 square inches; cross-sectional area of rim through flaw, 83.2 square inches; weight of rim, 6130 pounds.

The strength of the rim through the flaw was first considered and, using the following formulas and process, the factors of safety were found:

$$\frac{r^2 \times D \times W}{5870} = \textit{Total centrifugal force} = t$$

$$\frac{t}{6.28} = \textit{Total force to tear apart at one point} = f$$

$$\frac{f}{a} = \textit{Pounds pressure per sq.in. of cross-section}$$

In which

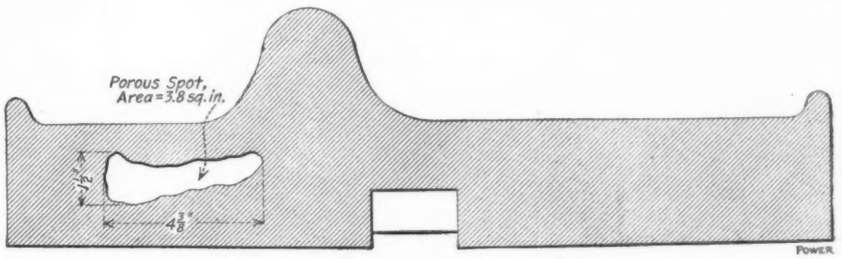


FIG. 1. SECTION OF FLYWHEEL RIM

a = Area of cross-section;
r = Revolutions per minute;
D = Mean diameter;
W = Weight.

Now $D = 7.2$ feet, $W = 6130$, $r = 180$ and $a = 87 - 3.8$ (flaw) $= 83.2$ square inches. Substituting these values in the above formulas gives the following results:

$$\frac{180 \times 180 \times 7.2 \times 6130}{5870} = 243{,}612 \textit{ lb.} = t$$

$$\frac{243{,}612}{6.28} = 38{,}791 \textit{ lb.} = f$$

$$\frac{38{,}791}{83.2} = 466.2 \textit{ lb. pressure per sq.in. at flaw}$$

Cast iron in flywheels can be safely allowed a tensile strength of 15,000 pounds and on this basis the factor of safety on centrifugal force is in this case

$$15{,}000 \div 466.2 = 32.1$$

As this increases or decreases in proportion to the square of the velocity, the factor of safety on the speed is

$$\sqrt{32.1} = 5.6$$

Or, in other words, the speed could reach

$$5.6 \times 180 = 1008$$

revolutions per minute to reach the limit of safety if the rim is considered alone, through the flaw section.

As a matter of fact, the joint of the wheel is much weaker than at the above section. In considering the strength of the joint, the cross-section of the rim without the flaw will also be considered. By referring to the data of this wheel, the pounds pressure per square inch of the rim may be computed and found to be

$$38{,}791 \div 87 = 445$$

As this design of wheel has only one-quarter the efficiency of a solid wheel, the allowable stress is

$$15{,}000 \div 4 = 3750 \textit{ pounds}$$

The factor of safety on centrifugal force is

$$3750 \div 445 = 8.2$$

The factor of safety on speed is

$$\sqrt{8.2} = 2.8$$

It can be seen by this that the strength of the rim containing the flaw was much stronger than the joint.

That the joint did not fail in any other way than would be expected from excessive speed is shown first by the evidence of the assembled fragments shown in Fig. 2. Referring to this figure it may be seen that joint *B* failed first, then the opposite section of rim from arm to arm containing the other joint left the wheel and the other parts followed these.

Prof. Charles H. Benjamin in his valuable reports in Volume 20, page 209, and Volume 23, page 168, of the *Transactions* of the American Society of Mechanical Engineers gives conclusive data on the manner in which wheels of this type fail. In every case the failure occurred in

the same way as in the wheel in question.

Professor Benjamin tested wheels of 15 to 44 inches in diameter and made of closer iron than the average. He found the tensile strength of the iron to be 19,000 pounds, but on larger wheels it is safer to allow 15,000 pounds, as was done in considering this wheel. He also found the maximum and minimum rim velocities at the bursting point to be 196 and 184 feet per second, respectively, that is, the highest and lowest velocities at which any of the wheels in his tests let go. These tests verify the fact that the wheel in question was well within the limit of safety at its rated speed.

The acceptance test also brought out the fact that the engine was governing within its rated percentage as evidenced by speed tachometers, and the valves were covering the steam ports properly, as shown on the indicator diagrams. The diagrams show that with the throttle wide open and no load, the initial pressure in the cylinder was 29 to 30 pounds less than the steam pressure in the pipes and with full load the drop from steam pressure to initial was 2.5 pounds.

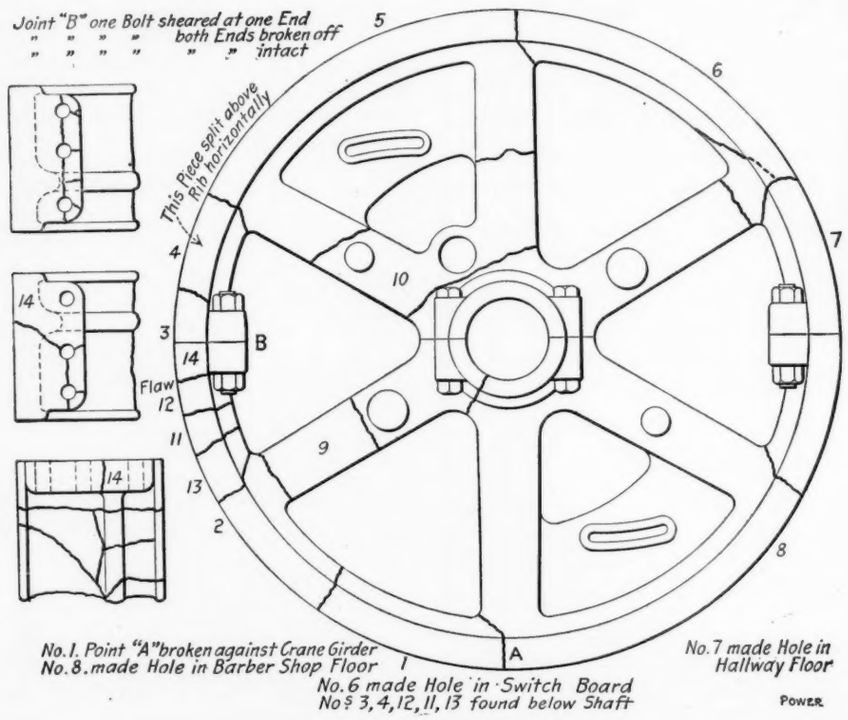

Joint "B" one Bolt sheared at one End
" " " " both Ends broken off
" " " " " " intact
This Piece split above Rib horizontally
Flaw
No. 1. Point "A" broken against Crane Girder
No. 8. made Hole in Barber Shop Floor
No. 6 made Hole in Switch Board
Nos 3, 4, 12, 11, 13 found below Shaft
No. 7 made Hole in Hallway Floor
POWER

FIG. 2. THE BROKEN WHEEL REASSEMBLED

REAL CAUSE OF ACCIDENT

Having disposed of the flywheel probability, the real cause of the accident may be investigated. Fig. 3 shows the governor and wheel of this engine. The accident stripped the wheel completely from the shaft, and after the parts were assembled it was found that the link pin *A* was scored and cut and some of the brass from the link bushing had fused to the steel pin. This pin is shown in detail in Fig. 4. Where this brass fused to the steel it left little ridges of metal. By referring to Fig. 3, it may be seen that the two weight-arm links *B* and *C* are made fast to the eccentric by pin *A*. This pin passes through one end of each link. These links are brass bushed, and on the inside of the link next to the eccentric were found the plain marks of threads. Pin *A* made up tight in the boss of the eccentric against the shoulder *A*, Fig. 4. This made it self-locking. The two link ends fitted the large end of this pin.

This engine had been put in service at 2 a.m. on the day of the accident and was in service continuously up to the time of the accident, close to fourteen hours. No trouble was noticed until a few seconds before the accident, when a heavy pound started in the governor and then the engine suddenly speeded up, the generator making an ever increasing screeching noise. The engineer on watch started for the throttle and before he could reach it, the wheel exploded.

The evidence showed that the link pin was dry and had run hot. This had loosened the pin from the eccentric by pinching it, and the movement of the governor had gradually worked it loose until it was still holding by two or three threads; but there was still room enough for the inside link to pound on the threads between the shoulder *A*, Fig. 4, and the eccentric boss. That it did so pound is shown by the plain marks of threads on the inside of the bushing on the link. The pin was long enough in the thread to still hold and allow this.

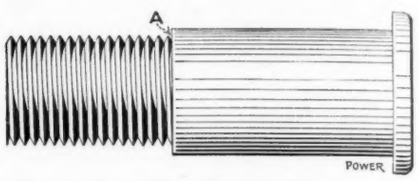


FIG. 4. LINK PIN WHICH CAUSED THE ACCIDENT

This was when the pounding occurred a few seconds before the explosion. Then the most plausible theory is that the pin was pulled out of line enough to bind the governor and cause it to stick and let the engine run away.

Some criticism was made of the fact that this pin had no lock nut. On the contrary, there was no need of such, as it locked against the shoulder.

The final conclusion as to the primary cause of the accident was that "the pin was dry."

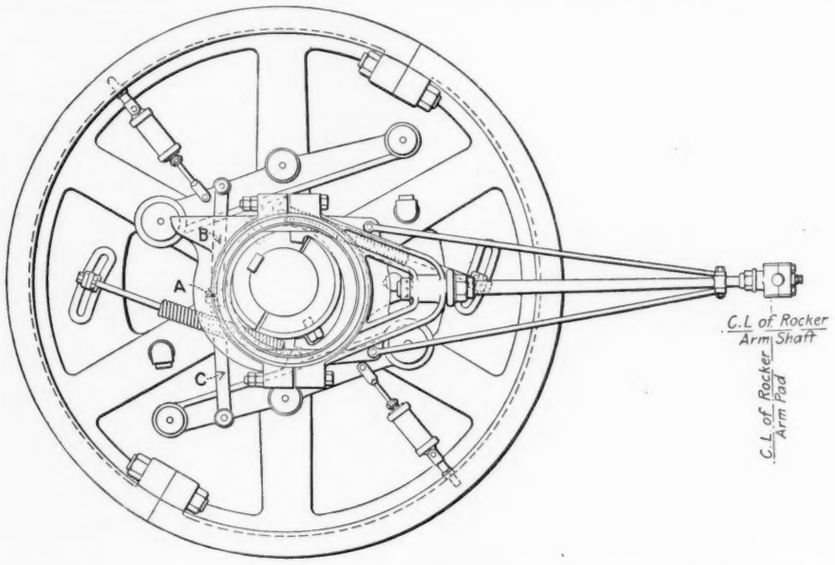


FIG. 3. THE GOVERNOR AND WHEEL AS THEY APPEARED BEFORE THE ACCIDENT

A Turbine Driven Roller Mill

A 750-horsepower Parsons turbine, designed to run at 2000 revolutions per minute, is geared to run the mill at 70 revolutions. A 100-ton flywheel takes up the shock of the mill.

The rolling-mill field, looked upon as one of the last and most secure strongholds of the reciprocating engine, has been invaded by the steam turbine. An installation at the Calderbank steel works of James Dunlop & Co. was the subject of a paper recently presented to the West of Scotland Iron and Steel Institute by A. Quintin Carnegie, of the Parsons Company.

About the time that the Parsons were experimenting with the "Vespasian," upon which it will be remembered the speed of the turbine was reduced to that of the propeller through gears, the question of the motive power for the new rolling mill was up, and it was proposed to use the exhaust steam from the existing mill engines for electrically driving the new mill through a low-pressure turbine. Calculations showed that a flywheel already on hand was large enough to permit the rolls to be operated with an almost constant load on the driving engine, and the idea of substituting gearing for an electrical reduction between the turbine and flywheel shaft presented itself. The electrical transmission would cost something like 15 per cent. in transformation losses, whereas the frictional loss, including that of the bearings of the gearing, would not be over 1½ per cent., while the gearing involved a much smaller investment.

The turbine, of which the accompanying section, Fig. 2, is reproduced from *The Engineer* and the halftone view, Fig. 1, from *Engineering*, is of the Parsons mixed-pressure type and runs at 2000 revolutions per minute, either with exhaust steam at a pressure of 16 pounds per square inch absolute, or with live steam direct from the boilers at a pressure of 60 pounds per square inch above the atmosphere. The two throttle valves are connected to the governing mechanism by means of steam relays and are arranged so that preference is given to the use of exhaust steam. When the supply of exhaust steam is insufficient, the balance required is automatically supplied by the high-pressure valve, the distribution of the load between high-pressure and exhaust steam being effected by the decrease in speed. In order to prevent air from being drawn in when there is a shortage of exhaust steam, a small device is provided, which causes the low-pressure throttle to close whenever the exhaust steam falls to nearly atmospheric pressure. The blade areas are so proportioned that the full load may be carried with atmospheric pressure at the first row of low-pressure blades, the high-pressure blades in this case running idly in steam of atmospheric

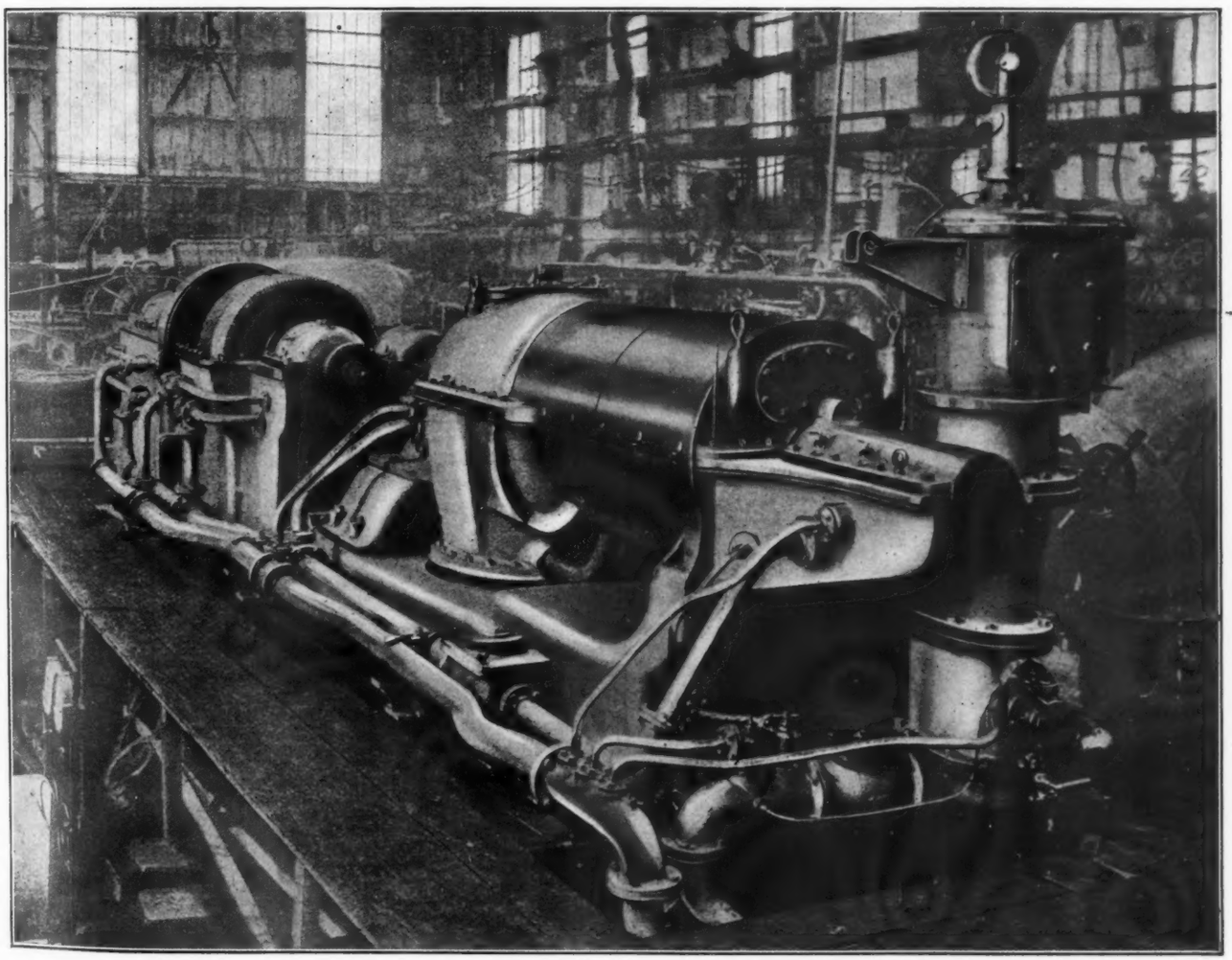


FIG. 1. GEARED TURBINE FOR ROLLING MILL, LIVE STEAM END

pressure. When the whole load is taken by high-pressure steam, the pressure in the first row of low-pressure blades falls to about eight pounds absolute, so that the smaller quantity of steam is still able to fill the blades and maintain an efficient velocity ratio. Full power from the turbine may be obtained from either source of steam supply or a mixture of the two.

bearings under a pressure of from eight to ten pounds per square inch by a pump driven from an extension of the governor shaft, but the oil for the gearing is delivered by a separate pump driven from the intermediate shaft by means of a Reynolds silent chain. This pump draws oil from settling chambers in the bottoms of the gear cases and sprays it continuously onto the teeth.

20 times that of the turbine and gears, it is evident that the latter are subjected to a small fraction of the shock due to the rolling mill. The flywheel shaft is connected to the main pinion of the mill by a pair of wobbling couplings. One of these is of cast steel, while the other is of cast iron, of such section as to allow its breaking in the event of any undue strain on the mill. Four of these

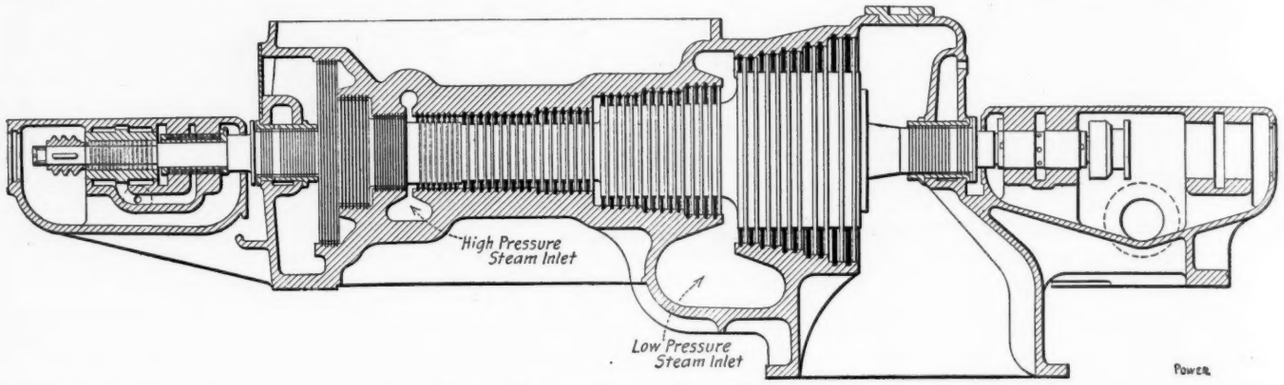


FIG. 2. LONGITUDINAL SECTION OF TURBINE

The turbine was designed to develop 750 brake horsepower, and this has been found to be ample. The mill runs at 70 revolutions per minute, the turbine at 2000 revolutions and the intermediate shaft at 375 revolutions. The high-speed pinion is formed solid with its shaft and is made of chrome-nickel steel. The pitch-line diameter is 7.143 inches, and there are 25 teeth, 3½ inches diametrical pitch. The wheel into which it gears has 131 teeth and is 37.429 inches in diameter, with a total face width of 24 inches. The second reduction gear has a mild steel pinion, with 23 teeth, 2 inches circular pitch. The pitch circle diameter is 14.912 inches, and it gears into a wheel of 80.848 inches diameter, with 127 teeth. The total face width of the low-speed gear is 16 inches. The double helical teeth are at an angle of 23 degrees with the axis of the shaft. Both pairs of gears are placed in cast-iron gear cases with white-metal bearings for the shafts. Oil is pumped into the

The level of the oil is kept sufficiently low to be quite clear of the bottoms of the wheels. The arrangement of the gear is shown in Fig. 3 herewith, also reproduced from *The Engineer*. Couplings of the flexible type are fitted between the turbine and the high-speed pinion shaft, and also between the first and second reduction gears. These allow for small errors in the alinement of the shafts, and also give the necessary end freedom for expansion of the turbine shaft.

Together with its shaft the flywheel weighs nearly 100 tons. It is carried on two adjustable gun-metal bearings, each 22 inches in diameter. One of these bearings forms part of the lower-speed gear box. The low-speed gear wheel is keyed directly on to the end of the flywheel shaft and is overhung from its bearing. The flywheel, which is of cast iron, is in two portions, connected with the usual shrunk links. The external diameter of the wheel is 23 feet. Since the stored energy in the flywheel is about

couplings are said to have broken in one afternoon.

The Summer School of Engineering under direction of the College of Engineering of the University of Wisconsin, opens June 26, continuing for six weeks. Regular and advanced courses are offered in direct and alternating currents, hydraulics, machine design, descriptive geometry, applied mechanics, shopwork, steam and gas engineering and surveying. Elementary courses adapted to the requirement of those not having preparation for the advanced work are offered in me-

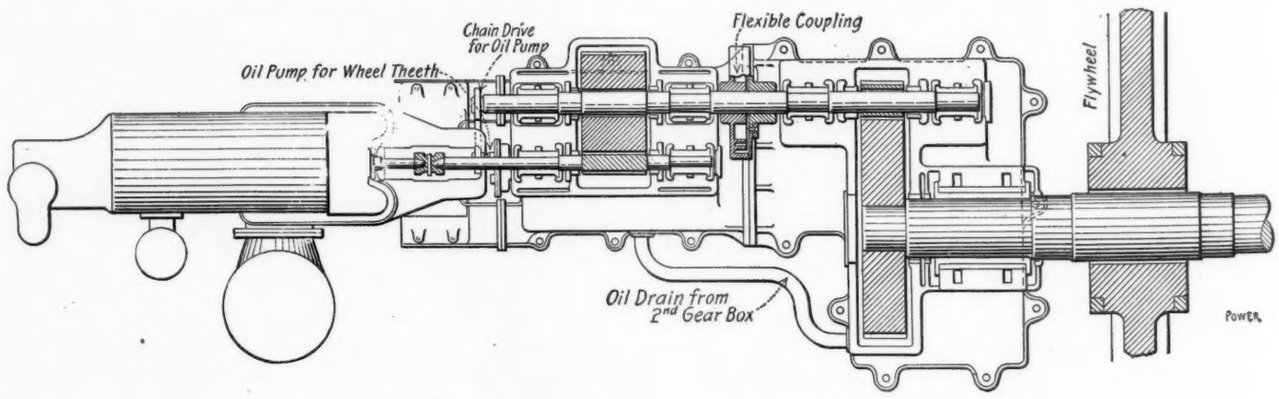


FIG. 3 GENERAL ARRANGEMENT OF THE GEARS

chanical drawing, machine design and shopwork, in addition to which opportunity is offered for laboratory work in the electrical, steam and gas laboratories for those who have had power-plant experience or correspondence instruction. The teaching staff is taken from the regular instructional force, and all laboratory equipment of the engineering college is available for students.

Napier's Formula with Superheat

Some experimental observations upon the flow of superheated steam through an orifice. By applying these values to Napier's formula constants for superheated steam were obtained.

A short time ago, Mr. Harter presented a paper, at a meeting of the American Society of Mechanical Engineers, setting forth some incidental observations upon the value of Napier's coefficient with superheated steam. The values recorded were for superheats between 45 and 195 degrees Fahrenheit, but unfortunately the series was confined to a range of pressures between 138 and 148 pounds gage. Extreme care was taken in making all observations and the probable error was within 0.2 of one per cent.

The same orifice was used in all the tests and was formed in a ½-inch plate with edges rounded to a ¼-inch radius, the contracted diameter being 1.2 inches. In figuring the results no correction was made for expansion due to the temperature of the diaphragm, owing to the smallness of the error arising from this source.

The results are plotted in Fig. 1, in which curve No. 1 gives the Napier coefficient corresponding to each set of readings obtained in the tests. Calibration tests of the orifice for saturated steam showed a coefficient of about 72.3, the difference between this and the ordinarily accepted figure of 70 being, no doubt, due to the form of orifice. The formula for determining Napier's coefficient as plotted in curve No. 1 is

$$C = \frac{p\,a}{W}$$

where,

C = Napier's coefficient;

p = Test pressure, absolute;

W = Weight of steam flowing per second;

a = Area of the orifice in square inches.

Curve No. 2 shows the cubic feet of steam discharged per second for different amounts of superheat, the results being reduced to the basis of the average pressure existing during the tests in order to make the volume discharged depend upon temperature only.

Curve No. 3 shows the weight of steam discharged per second at the average pressure.

In commenting upon Mr. Harter's results, Professor Heck submitted some interesting comparisons of experimental results with the Napier formula, as follows:

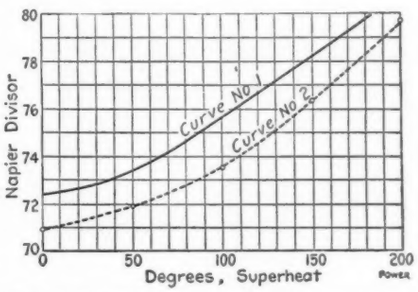


FIG. 2. THEORETICAL AND EXPERIMENTAL VALUES OF NAPIER'S CONSTANT

COMPUTATIONS FOR POINTS ALONG CURVE NO. 2, FIG. 2

Degrees of superheat	0	50	100	150	200
Initial temperature t_1, degrees	363.6	413.6	463.6	513.6	563.6
Entropy	1.5646	1.6010	1.6316	1.6596	1.6846
Condition of steam at p_0, quality or temperature	0.9611	0.9930	353.8	397.6	440.0
Total heat h_1 at p_1, B.t.u.	1194.9	1225.3	1253.0	1279.3	1304.6
Total heat h_0 at p_0	1150.1	1178.6	1202.9	1226.4	1250.5
Energy of jet $(h_1 - h_0)$	44.8	46.7	50.1	52.9	54.1
Velocity v_0 at p_0, feet per second	1495	1526	1580	1623	1641
Specific volume v_0 at p_0, cubic feet	4.606	4.760	5.043	5.377	5.682
Cross-sectional area a_0 of one-pound jet at p_0, square inches	0.443	0.449	0.460	0.477	0.498
Napier divisor, $N = a_0 p_1$	70.9	71.9	73.5	76.3	79.7

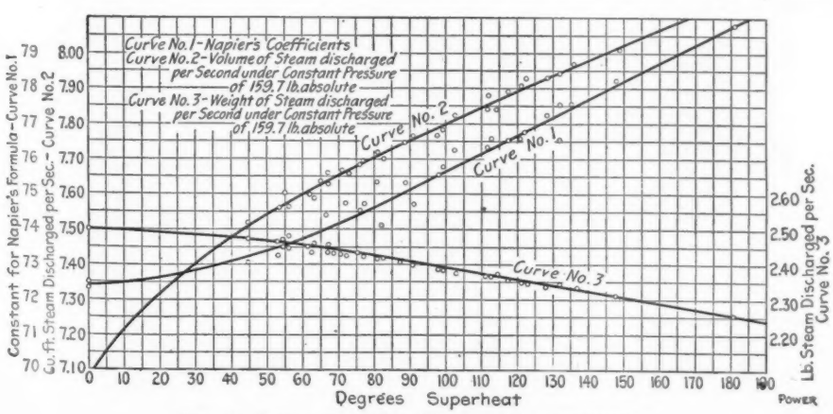

Curve No. 1 - Napier's Coefficients
Curve No. 2 - Volume of Steam discharged per Second under Constant Pressure of 159.7 lb. absolute
Curve No. 3 - Weight of Steam discharged per Second under Constant Pressure of 159.7 lb. absolute
Curve No. 2
Curve No. 1
Curve No. 3
Constant for Napier's Formula - Curve No. 1
Cu. Ft. Steam Discharged per Sec. - Curve No. 2
Lb. Steam Discharged per Sec. Curve No. 3
Degrees Superheat
POWER

FIG. 1. RESULTS OF MR. HARTER'S EXPERIMENTS

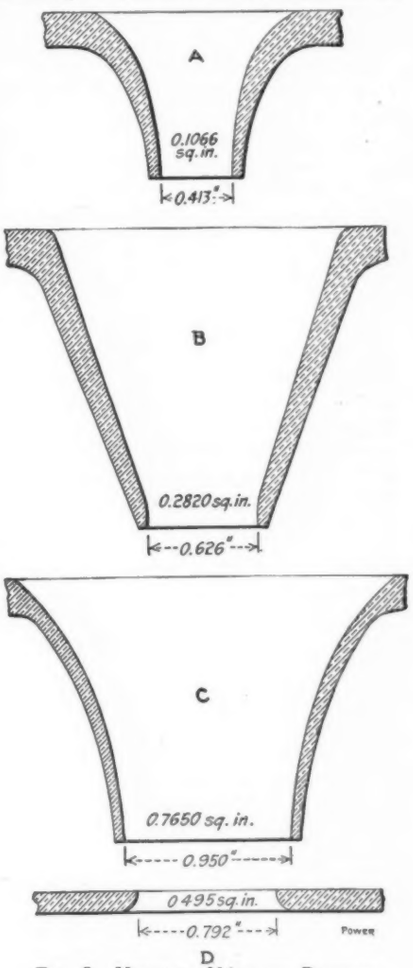


FIG. 3. NOZZLES USED BY RATEAU

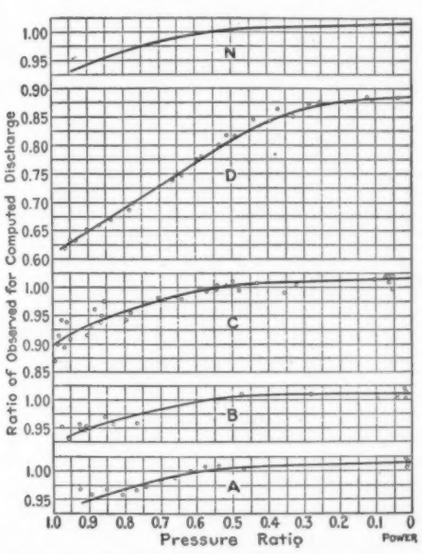


FIG. 4. CURVES SHOWING FLOW WITH NOZZLES SHOWN IN FIG. 3

sults with the theoretical values of Napier's divisor deduced from the truly adiabatic steam jet.

In Fig. 2, curve No. 1 represents Mr. Harter's curve No. 1, while curve No. 2 shows the ideal value of the Napier constant. The calculation for the five points along this curve is outlined in the accompanying table. The general data are: initial pressure p_1 equals 160 pounds absolute; pressure in throat of jet p_0 equals 92 pounds absolute, or 0.575 p_1, for which pressure the saturation temperature is 321.9 degrees Fahrenheit:

The steam quantities in this calculation were taken from an as yet unpublished table of the properties of steam, which differs from the Marks and Davis tables by amounts lying within the region of experimental indeterminateness.

The two curves in Fig. 2 show agreement in form, and indicate a coefficient of discharge of 0.97 to 0.98; this coefficient being the ratio of the ideal to the observed value of *N*.

In this connection it is shown how the coefficient of discharge works out for an important set of experiments made by Rateau, in 1900. Fig. 3 shows the nozzles and orifice used. In Fig. 4, curves *A*, *B* and *C* correspond with nozzles *A*, *B* and *C*, respectively. The curve *N* is the average of these three, while *D* applies to the sharp-edged orifice. The pressure ratio is the ratio of the final to the initial pressures, that is, $p_2 \div p_1$. The ideal flow is based on the assumption that when p_2 falls below 0.575 p_1, it ceases to exert any influence upon the rate of flow. These experiments show that it has a small influence; the discharge is equal to the ideal rate when p_2 is the same as the throat pressure p_0, but increases very slowly as p_2 falls. The coefficient of discharge thus becomes greater than unity, being about 1.02 when p_2 equals 0.1 p_1, which is about the governing condition in the tests reported by Mr. Harter. Curve *D* shows a marked contraction of the jet, which decreases, however, as p_2 becomes less.

Flow of Heat through Furnace Wall

A set of exhaustive investigations have recently been completed at the fuel-testing plant of the United States Geological Survey at Pittsburg, Penn., by Messrs. Ray and Kreisinger upon the flow of heat through furnace walls. A specially constructed furnace was used, all temperature measurements were taken by means of thermocouples and every precaution was observed to insure accurate results.

As a result of recent investigations at the testing plant of the United States Geological Survey it has been found that a solid wall is a better heat insulator than a wall of the same total thickness containing an air space.

The temperature difference was taken as a basis for measuring the relative heat transfer, the nearly true assumption being made that there is no cooling effect due to leakage currents of air through the brickwork or into, out of or along the air space. With this true, the quantity of heat passing through an inner part of the wall is exactly equal to the heat passing through another part farther out. For example, the quantity of heat which is conducted through the inner firebrick wall is exactly equal to the heat which passes across the air space, and is exactly equal to the heat which is conducted through the outer common brick wall, and also equal to the heat radiated from the outside surface. If this were not so, equilibrium would be impossible; that is, if more heat passed through the inner wall than through the outer wall and over the air space, then the heat would accumulate next to the air space and would be accompanied by a continually increasing temperature. Or, if more heat passed through the outer wall than through the inner one and through the air space, the heat in the outer wall would diminish and its temperature would drop—an event contrary to conditions of equilibrium.

The quantity of heat flowing by conduction from one plane to another through any portion of the furnace wall depends upon the difference of temperature between these two planes and upon the resistance to the heat flow. With the same temperature difference, if the resistance is high, a small quantity of heat flows through; if the resistance is low, a large quantity flows through. Or, if the quantity of heat is to remain constant, the temperature difference must be large if the resistance to the heat flow is high, and small if the resistance is low. For example, if the temperature difference between the faces of the firebrick wall is high, it may be said that the resistance to the heat flow through the firebrick wall is high; or, if the temperature difference between the two surfaces on each side of the air space is low, it may be inferred that the resistance to the heat passage across the air space is low. Thus it is possible to rely upon the temperature difference as being a true indicator of high or low resistance to heat flow between any two planes which are parallel to the surface of the wall.

The investigations particularly concerned the air-space type of wall construction as compared with the solid brick wall or walls in which the air space is filled with some solid material of low heat conductivity. The results showed conclusively the rather surprising fact that in furnace construction a solid wall is a better heat insulator than a wall of the same total thickness containing an air space. This is especially true if the air space is close to the furnace side of the wall. In view of this, where it is desirable to build the walls in two parts, so as to prevent cracks from being formed by the expansion of the brickwork, it is preferable to fill the space with some solid (not firm but loose) insulating material. Any such materials as ash, crushed brick or sand offer higher resistance to the flow of heat than an air space; furthermore, a loose material by its plasticity reduces the air leakage. It was found that one inch of asbestos was more effective as a heat insulator under the existing conditions than a 2-inch air space.

There is a general belief that since air is a poor conductor of heat, air spaces built into the walls of a furnace will prevent or reduce heat dissipation through the walls. Although there may be instances in which this is true, yet, as a rule, the effect of the air space is just the opposite. While the heat travels very slowly through the air by conduction, it passes over the air space very readily by radiation.

The quantity of heat passing through a portion of a solid wall by conduction depends upon the difference between the temperatures of the two planes limiting the portion of the wall, whereas the quantity of heat that passes across the air space in a wall depends upon the difference of the fourth powers of the absolute temperatures of the surfaces inclosing the air space. It follows that, in case the heat passes by conduction through the solid portion of the wall, the loss remains approximately the same so long as the temperature difference of the two limiting planes remains constant, no matter what may be the actual temperatures of the two planes. On the other hand, the heat passing across the air space by radiation increases rapidly with the temperatures of the inclosing surfaces, although the difference between these temperatures may remain constant. The important point is that the air space, which is advantageous in the walls of a refrigerator because the temperatures are low, is objectionable in a furnace wall because the temperatures are high.

A Perpetual Hydraulic Motor

By F. W. Salmon

How a young engineer was induced to spend his time working on a perpetual-motion machine which he knew was contrary to all natural laws and which he felt sure could not be made to work. The deception that he discovered and exposed and the lessons that he learned.

About the middle of a warm holiday afternoon in May, 18—, in the western corridor of an upper floor of a downtown office building in a city of the Middle West, an elderly man dressed in a gray suit was carefully searching for a certain door. This was made evident by the close examination he gave each door in turn. Although he was apparently fifty-five or sixty years old and had silver-gray hair, his walk was firm and decided; his face was clean shaven and he bore himself with a semi-military air.

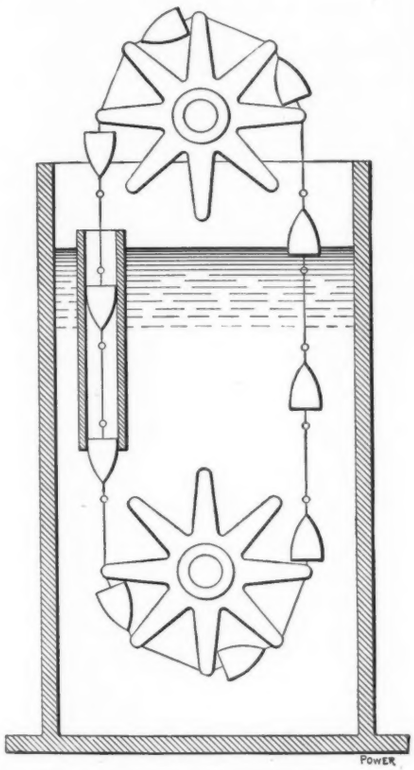


FIG. 1. SMITH'S ORIGINAL DESIGN

At room 418, after examining the sign on the glass, he tried the knob, but it would not turn. The door was opened by a man of perhaps twenty-five years. A few preliminaries and the men were acquainted; Charles F. Smith wished to consult Henry C. Bandcox about the former's invention—an invention that had been his dream day and night for perhaps thirty years. The dream was not a dream to him but, rather, a duty, his duty, to his race, his nation, yes, to the world.

Bandcox's erect carriage, his open and frank manner and the way in which he looked others straight in the eye, all carried confidence, surely he was honest and honorable, and surely he had a right to practise his profession as a consulting engineer, even though he was so young, for he had been trained in the best schools, the school of theory, the school of practice and the school of adversity.

Smith's most intimate friend, Hammond, had told him to find this man Bandcox and secure his service in perfecting the invention; Bandcox had but a small practice and Hammond knew that he would give almost unlimited study and care to anything he undertook.

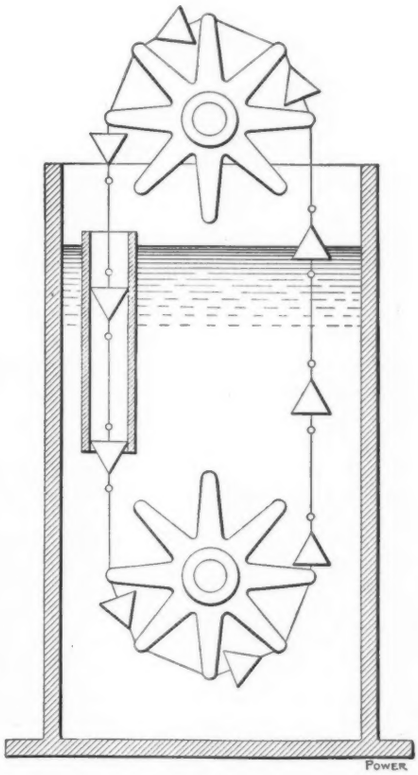


FIG. 2. SMITH'S FIRST IMPROVEMENT

An hour later Smith folded up and put back in his pocket a sheet of paper on which there was a sketch, as shown in Fig. 1, while the words, "You are mistaken, Mr. Bandcox, I have seen it move, I know that there is power in it," were leaving his lips, and upon his face was a more set and determined look than before. Henry, in wishing him good-by at the door, courteously repeated his firm belief that no useful or profitable purpose could be attained by spending money on or time experimenting with such a device.

The old man had for half a lifetime treasured the idea that in the near future any man would be able to get power almost without cost with his device, as soon as some consulting engineer would show how to get the floats down again under the bottom wheel and mechanics would do "decent" work on his models, thus not allowing excessive friction to prevent the machine from making the initial move when tested.

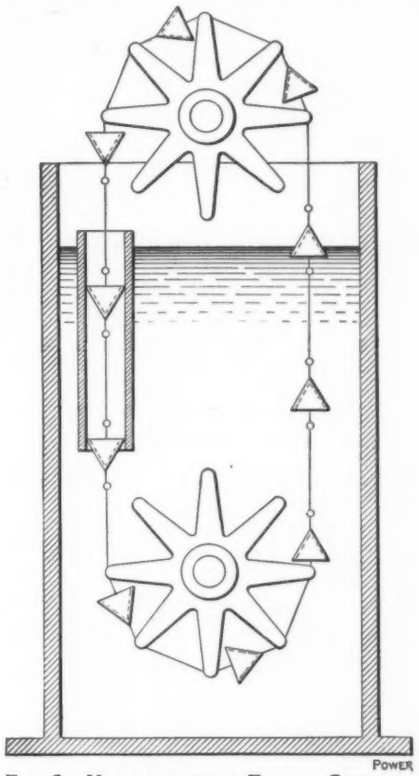


FIG. 3. MACHINE WITH FLOATS OPEN AT THE BOTTOM

The floats were made with the shape shown in Fig. 1, upon the theory that they would pass through the water with less resistance at the enormous speed that in the inventor's opinion they would attain in large machines when operated in deep water.

Perhaps a week later Smith again called on Bandcox, this time accompanied by his friend Hammond. Smith asserted that if a practical machine were designed and a satisfactory working model made to show to capitalists, unlimited capital would immediately be

placed at their disposal. Hammond vouched for the excellent reputation of Smith and assured Bandcox that Smith would undoubtedly pay his bills for services promptly. Moreover, Hammond emphatically declared that he had seen a model run, though it was roughly made and very small. Bandcox, however, could

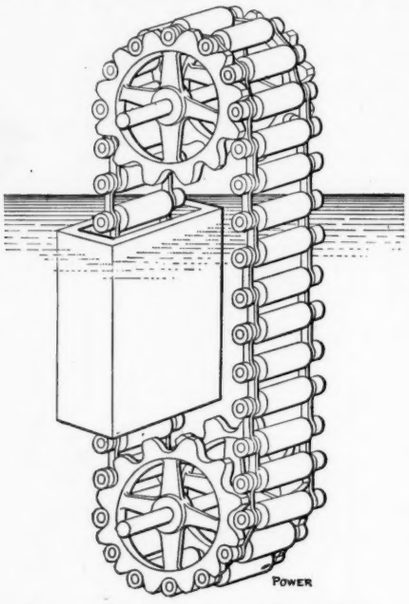


FIG. 4. FLOATS BUILT AS ROLLERS TO ELIMINATE FRICTION

not reconcile this with his theoretical knowledge.

During the discussion sketches as per Figs. 2 and 3 were made. In Fig. 2 the inventor arranged for a water-tight tube in which the floats were to pass downward. This was to nullify the objection raised by Bandcox that in the earlier design the efforts on the various parts of the chain were equally balanced.

In the design in Fig. 3 Smith thought he had solved every difficulty. The floats were open at the base of the cone so that they would fill with water in descending. Bandcox explained that there was nothing to cause them to rise on the ascending side.

Smith called later with pieces of the apparatus that it was claimed had "run"; still, Bandcox claimed that the machine was not feasible and advised against spending money in models or patents. But, Smith insisted that drawings be made upon which an application for a patent could be based. Finally, this was done; the drawings showed a design very similar to that in Fig. 4. Smith explained that in this design the last objection offered by Bandcox had been met, for should any of the floats in descending touch the side of the tube they would roll and thus not offer the resistance which was found so objectionable in the design in Fig. 2.

After this, Smith often called at Bandcox's little office, sometimes bringing interested friends with him, and many methods were talked over as to "the best way to overcome the cussedness of the thing," but Bandcox always protested against the machine as not being feasible. Still, Smith had several models made and these altered from time to time but to no purpose. So, gradually, his visits to Bandcox became less frequent and finally ceased entirely.

On one cold day of the following spring, Bandcox sat in a little workshop at a board on trestles in one of the back rooms of the factory of—well, let's say the Olivett Manufacturing Company, in the small town of, say, Olivett. He was a good engineer and a good student, but he was neither a good "business getter" nor a good "cash collector" so he had given up his office with the last of his little capital and "taken a job" on a small salary with an expert "business getter"

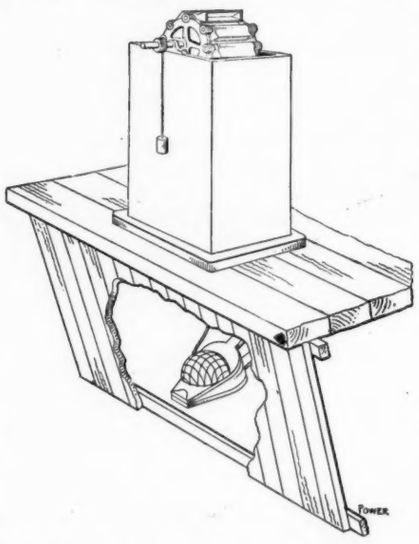


FIG. 5. HOW THE MACHINE WAS MADE TO WORK

who reaped large profits from Bandcox's labor and skill.

A letter in an envelop bearing several "Forwards" was thrown in to him; he shoved it in his pocket but later his curiosity awakened, apparently, and he opened and read it.

What, was it possible! Smith's machine a success—runs nicely and gives greater power than even the inventor claimed. A model had been made by Thompson, the modelmaker on Water street, and it was now in his shop where it runs daily and is seen by hundreds. The letter ran on, Smith wanted Bandcox to come at once and make the drawings and specifications, both for the patent and for a larger machine. The evident rectitude and honor of Bandcox had so impressed Smith and Hammond that they searched for him at this important time.

A few letters were exchanged and Bandcox paid out his hard earned wages for a ticket to go back to his home town. When he arrived he went directly to the model shop and found Smith waiting for him, more erect than ever, cordial and kind. Now what did Bandcox have to say? There was the machine, just like one of the sketches made in Bandcox's office which he had always thrown down as "not practical, no good, out of the question." This model ran and it gave power, yes, *power*. See it raise this large weight when the clutch is thrown in. Yes, Bandcox gives in, acknowledges that it works, that it gives power but he still insists that in some way or in some detail not readily discernible it differs from the sketches that were shown to him some months before.

Smith and Thompson talked and acted as though they thought Bandcox more or less insane. "Would he not believe what he saw with his own eyes?" Just pour in a few drops of fresh water and the machine would start, run and give power; anyone could pour in the water that Thompson would courteously hand him when desired.

The young engineer was quite busy for the next two weeks, examining the machine and its surroundings, measuring the volume of water it took, the weight it would raise and doing many other things. At last, he had his report ready to show Smith, Hammond and Thompson

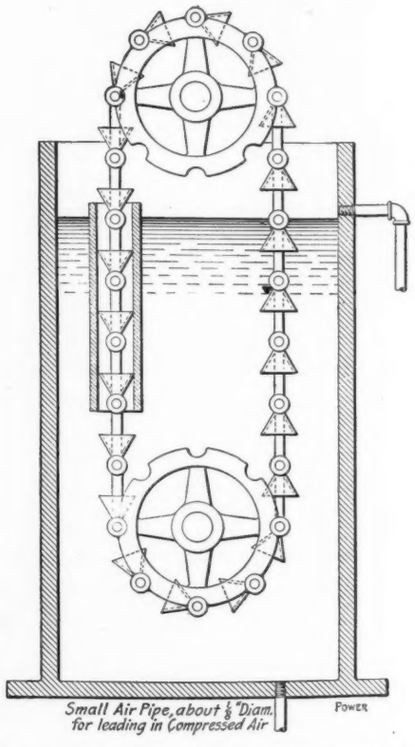


FIG. 6. SECTION OF MACHINE, SHOWING AIR SUPPLY

what he had found. How simple! For months a man in Thompson's employ had been drawing good wages for himself and for Thompson working on the model. The model worked because a small pipe conveyed air into the water tank just under the ascending buckets, as shown

in Fig. 5. The duty of the man whom Thompson employed was to work the foot bellows and keep out of sight. The air entering the bottom of the tank came in contact with the floats on the up side, as shown in Fig. 6, and caused the machine to work.

The exposure of Thompson's deceit caused Smith such great disappointment that he gave up in despair his cherished dream of securing power without cost.

Bandcox went back to his position in Olivett, poorer in pocket but richer in experience and wisdom.

It was but a short time ago that I sat on one side of the fireplace in Henry Bandcox's home on a cold night and Henry sat on the other. We were finishing our cigars after his family had retired and we talked of the incidents recounted above. He went on to say that it was a bitter experience and had cost him a high price one way and another but he learned many things by it. For instance, a young engineer, wishing to run a consulting office, must be a "business getter" as well as an engineer. He should not pay out much of his own cash for his clients but, on the contrary, should have them put up the cash for expenses as needed and balance often. Again, if a client comes along with something that is worthless, have nothing to do with it—just *have nothing to do with it,* drop it and keep away from it as though it were dynamite, for the only bills that are paid cheerfully (if any are) are those that represent a part of some profitable venture or transaction. Although some men seem willing to profit by the losses of their clients, honorable men would not wish to.

Economical Generation of Steam

By William Kavanagh

Attention is called to the losses occurring through poor firing and lack of attention to the boiler-room equipment. Suggestions for minimizing these losses.

Economy in a steam-power plant primarily begins in the boiler room, and depends largely upon two factors: good firing and proper care of the equipment. It will not suffice to spasmodically clean boilers, repair furnaces and occasionally put the grate bars in good order.

How then are the highest economical results to be obtained in the boiler room? This question is partly answered by having the boiler equipment in duplicate or, at least, in having a sufficient number of clean boilers to replace an equal number that have been running for some time. The period during which a boiler can be operated economically depends in a great measure upon the quality of the feed water and also upon the attention the boiler receives while under steam. If boilers are handled in the following manner, they may be operated economically or, at least, with as good economy as conditions will permit:

First, the feed water should be filtered and softened (if hard) and its temperature raised as high as possible before it enters the boilers. Second, the bottom blowoff should be opened at a time when the least ebullition is going on in the water. This will occur at about the time steam is to be raised in the morning, assuming the boilers are shut down for the night with banked fires. Just before spreading the fires the bottom blowoff should be opened and some water allowed to escape to the sewer or tank provided for that purpose. If the boilers have been properly set and fitted with an independent feed pipe, the greatest amount of deposit will be found at or near the blowoff; therefore, it is poor policy to feed and blow through the same pipe, especially if the boilers cannot be shut down regularly for cleaning. The blowoff should be located at a point in the boiler where the least amount of agitation is present in the water and it should be independent of the feed pipe. Furthermore, the feed and the blowoff should not be located at the same end of the boiler.

Another factor which has an important bearing upon economy is clean boiler tubes; these should be blown free of dust at regular intervals, as dust is a good nonconductor of heat and its presence on the surfaces of the tubes always denotes a loss of fuel. If the boilers be of the horizontal tubular type the tubes should be scraped as well as blown and, if they be of the water-tube type, the tubes should be blown both horizontally and vertically; the mere thrusting of a steam pipe between such tubes and allowing the steam to blow for a few moments is little better than nothing at all. In general, it will be found that the water-tube boiler is difficult to keep clean, and the blower used for blowing the dust from the tube surface should be bent to nearly a right angle so as to enable a jet of steam to be directed against the sides of the tubes as well as along their upper and lower surfaces.

The feed water can be raised to a sufficiently high temperature by employing what is known as the "series system." With this system the water approaches the boilers by stages, passing from one heater to another, the coldest water entering the coldest heater and the hottest water the hottest heater, being subjected there to the temperature of the hottest exhaust steam. The first heater is called the "primary" heater and if three heaters are used the middle one is called the "secondary" heater and the third the "main" heater.

This system is practicable only where the steam is taken from such sources as the receivers of a triplex-expansion engine. Where an economizer is used the water issuing from the main heater passes through the economizer and thence to boilers.

Another fault often met with in practice is that of leaving the feed line exposed. This is also true with respect to steam lines, engine and pump cylinders and steam chests. All surfaces containing steam should be covered when possible to prevent radiation. Furnace linings should be tight, and hollow walls should not be allowed in the boiler setting, and all cracks and leaks in the walls of the setting should be stopped.

The firing should be regular and in no case should the whole of the incandescent fuel bed be covered with fresh coal. Usually, the best method of firing is to cover one side of the fuel bed first and when this has reached its maximum incandescence the other side is covered, thus establishing an alternate method of firing. There is a wide difference of opinion as to how coal should be burned. Some firemen prefer the "sprinkling" method, that is, spreading the coal over the fire in a thin layer, repeating this regularly and often. The objection to this method is that the amount of cold air admitted to the furnace is largely increased. The opposite to this method is to fire heavy each time, thus excluding the cold air. This practice is also objectionable because a distillation of the volatile gases of the coal will occur and find their way to the uptake without being burned.

However, the most effective method of firing often depends upon local conditions and for that reason only experienced firemen should be employed. There is no doubt that a large percentage of the losses occurring in a steam-power plant originates in the boiler room and is incurred by poor firing, dirty boilers, poor boiler settings, dilapidated furnace lining and grate bars, loss of coal by allowing it to mix with ashes and also by having a bed of good coal lying on the boiler-room floor to be crushed into dust by continual walking upon it. Again, it is not uncommon to find a badly packed boiler-feed pump that must be run at high speed in order to maintain the water level in the boilers. Leaky pipes and joints, valves, etc., all have a tendency to increase the total loss.

Locomotive Tubes, Their Treatment*

By F. N. Speller †

In which the author touches on the main points requiring attention, such as corrosion, leaking, strength of material, weldability and uniformity of material.

*A paper read before the Pittsburg Railway Club, April 28, 1911.

†Metallurgical engineer for National Tube Company.

The tube industry owes much to the railroads for its development; in fact, the invention of lap welding may be traced to the necessity which arose on the building of George Stevenson's first locomotive for a tube which would be safer and stronger than the butt-welded tube, the only one made at that time. Since Stevenson's day the manufacture of locomotive tubes has increased in quantity and quality as the demands of railroad service became more exacting and the whole tubular industry was no doubt favorably affected thereby. Seamless steel tubes were introduced about 1886 and established a new standard of strength and ductility and endurance under many conditions of service. Later on, a satisfactory grade of soft steel was produced which could be lap welded like charcoal iron and this also has been much improved, so that there are now practically three classes of tubes for locomotive service: charcoal iron (lap welded), steel (lap welded) and seamless steel. Charcoal iron formerly was made from a special grade of pig iron made in a small blast furnace using charcoal fuel. The product of this furnace was charged into the refinery, where about one-half of the impurities were oxidized and fluxed away, the metal being subsequently treated in lots of 300 pounds or so in a slightly modified type of the old catalan forge with charcoal as fuel. The use of so much charcoal has necessarily been stopped and in many other respects the manufacture of charcoal iron for tubes has of late years been considerably modified. Of those changes we are not in a position to speak, for, as it was evidently impossible for obvious reasons to continue the manufacture of charcoal iron strictly along the old lines, we abandoned the making of charcoal-iron tubes about two years ago in favor of lap-welded and seamless steel, which had by that time been proved a fit substitute and in some respects decidedly superior to the older material.

When steel is spoken of in this paper the method of manufacture is referred to more than the finished product, as the steel used in the manufacture of tubes, as a matter of fact, is a purer form of iron than that made by the charcoal process, and like the older metal cannot be tempered.

A special grade of bessemer steel was at first used in the manufacture of lap-welded tubes, on account of its superior welding quality, but later on had to be abandoned as under some conditions it was found to develop brittleness in the beads after the tubes had been in service some time. The substitution of basic open-hearth steel low in carbon and with less than 0.05 per cent. phosphorus and sulphur has been found after more than two years' trial to entirely do away with any tendency of this kind, and as now made there is little difficulty in securing a strong weld with this steel. Seamless and lap-welded steel tubes are now made from practically the same grade of soft basic open-hearth steel.

It is a good thing for manufacturers and consumers to get together and learn each others' troubles. Perhaps out of the discussion to which we are leading up, something of value to both sides will result. Let us then take up what seem to be the main points requiring attention in the locomotive tube in order that it may give the best service under modern conditions.

Resistance to Corrosion

The manufacturer should furnish a tube in the best possible condition to withstand corrosion and pitting; that is, the metal should be as uniform in composition and density as it is possible to make it. Much can be done to lessen the tendency to pitting by proper attention to the making of steel and the way it is worked. We have been experimenting on this problem now for several years and have gone to considerable trouble in the matter of testing and inspection of material and in the process used for manipulating the steel so as to produce a tube which will resist corrosion as well as iron can be made to do so, and, judging from the reports of comparative service tests which have been received, steel so made is, in this respect, at least the equal of the best charcoal iron.

After all, however, the solution of this problem is largely in the hands of the user. Iron or steel will corrode in spite of anything that can be done if certain material is in solution in the water, particularly dissolved oxygen or carbonic acid. By the removal of these harmful agencies corrosion may be reduced to practically nothing. It is generally understood nowadays that water conditions have everything to do with corrosion, and the simplest solution of the problem is to treat the water with the object of making it as harmless as possible. The development of the modern tube to withstand corrosion and the treatment of water have together practically eliminated this trouble, so that it is rarely the case that tubes fail nowadays through pitting.

Leaking in the Flue Sheet

The construction and handling of the engine has so much to do with the trouble experienced from leaky flues that it is difficult to determine how much, if any, of the responsibility for this should be placed on the tube material. If railroad engineers will tell us what qualities are required in the tube to make it hold tight in the flue sheet, we will be glad to follow their suggestions as closely as possible. At the present time the steel tube is made as stiff as possible consistent with the best welding quality and ability to stand up successfully under expansion and beading in the tube sheet.

Strength and Ductility of Material

The tube should be of such quality as to stand repeated tightening in the flue sheet without cracking or showing undue evidence of fatigue, nor should these weaknesses develop during the life of the flue in service. The material found best adapted to give these properties is a special grade of soft open-hearth steel carrying not over 0.05 per cent. phosphorus or sulphur.

Weldability

The quality of the metal and method of handling are equally important in safe ending. Soft steel has been found somewhat harder to weld than charcoal iron, but it has been greatly improved in this respect. The necessity for a good welding quality steel is of first consideration in making locomotive tubes so that they may be easily safe ended, and this point has received a great deal of study, especially in the manufacture of lap-welded tubes where it is, of course, one of the first essentials to manufacture. Charcoal iron carries considerably more impurities than soft open-hearth steel, and these impurities form a self-fluxing mixture which facilitates welding. Railroad specifications have been so tightly drawn on composition in some cases as to work against the production of a good quality of steel for locomotive-boiler tubes by calling for unnecessarily low phosphorus and sulphur. There is now very good reason to think that a mistake has been made in this direction and that the general welding quality of the steel would be much improved, and the steel at the same time would lose nothing in other respects, if the maximum

phosphorus and sulphur limits were both raised to 0.05 per cent. With producer gas, now generally used of necessity, it is a very difficult matter to keep the average sulphur in the heat below 0.035 per cent. and in order to remove this sulphur in the open-hearth furnace the steel has to be held and worked in such a way as to frequently leave it dry and difficult to weld.

Before the steel can be welded in practice a fluid cinder must be formed on the surfaces which are to be united. If the metal is heated too far above the point at which this cinder should flow, it will be burned and destroyed. We endeavor to have the range of temperature between the cinder-forming and burning points in the steel as wide as possible, so as to assist in lap welding and give the largest margin of safety in safe ending. Considering the variety of the requirements it seems that the composition of the metal should be left largely to the discretion of the manufacturer so far as is consistent with a certain specified standard of physical quality in the finished tube. We frequently go to the trouble of rephosphorizing for the purpose of improving the fluxing and welding quality of the steel.

TUBE SUBJECTED TO CRUSHING-DOWN AND FLATTENING TESTS

The method of safe ending has as much to do with obtaining satisfactory results as the material, but no attempt will be made to lay down specific rules as to construction of the furnace and heating, for many of the practical shop men present who are welding flues every day are much more able to discuss this side of the problem. However, there are a few broad principles on the heat treatment of tube steel which should be taken into consideration. The preliminary heating of the body tube preparatory to flaring out the end should be carried to a bright orange color, judging by good shop light, 1750 degrees Fahrenheit. In the case of steel on steel, if the body tube is allowed to cool black after heating to this temperature and inserting the safe end the grain structure will be refined and the metal put in much better condition for the welding operation which follows. Moreover, if the preheated body tube is returned to the furnace without cooling, the metal may be crystallized or burned before the safe end has been heated hot enough to weld. Should there be any considerable difference in thickness between the safe end and body tube, it is evident that there is again a risk of overheating the one before the other is sufficiently heated to weld. If the body tube is returned to the furnace while red hot and the safe end is at the same time a gage or two heavier, there is, of course, all the more chance of crystallizing or burning the body tube at or near the weld. Taking unnecessary risks of this kind often explains subsequent failures which should not be charged up to the flue maker.

It is not unusual for a flue welder who has never handled steel to have trouble for a few days. Remembering the above points and using his experience to the best advantage as to the condition of his furnace, the character of the flame, temperature, etc., the average man will soon be able to do equally reliable work with steel as with charcoal iron, as the experience of welders all over the country will show.

UNIFORMITY OF MATERIAL

This is a quality which the tubes should have in a high degree, both as to physical and chemical properties. There is no difficulty as to the average steel tube nowadays standing the master mechanics' tests made on one sample out of each hundred tubes. We have, however, recently designed a machine to make the flange, crushing down and flattening test on each end of every tube. This gives assurance both as to the character of the metal in each individual tube and also, in the case of lap-welded tubes, as to the welding quality being satisfactory. Steel tubes are now made in one grade of material suitable for either body tube or safe ending.

There is no difficulty in making steel tubes to stand the Master Mechanics' test on one sample out of each hundred tubes, the company has, however, recently designed a machine to make the flange, crushing-down and flattening tests on each end of every tube, as shown in the illustration. This gives assurance both as to the character of the metal in each individual tube, and also in the case of lap-welded tubes, as to the welding quality of the material. Steel tubes are now made in one grade of material, suitable for either body tube or safe ending. Analyses of ends of tubes which have been used on railroads in the Pittsburg district showed that while the sulphur of the body tube is about 0.03 per cent. when new, the tube after being in service a year or so shows 0.06 per cent. of sulphur, and sometimes more, indicating that the steel gradually absorbs sulphur from the gases, which suggests that perhaps we are a little too particular as to the initial percentage of sulphur. The Master Mechanics' requirements are sulphur and phosphorus 0.05 per cent. In the analyses made during production the sulphur will average 0.03 to 0.035 per cent., and the maximum will exceed this. It is difficult to get the percentage of sulphur down to less than this without drying out the steel so as to impair its welding qualities.

DISCUSSION

Mr. Redding said that in their practice they brought the tubes up to a welding heat in one operation, stuck the safe end in and continued the heating without any cooling of the body tube, as Mr. Speller recommended. They had, however, very few failures under this process, with the cold-drawn seamless tubes. He thought that the absorption of sulphur from the fire was an additional reason why the initial sulphur should be kept down. With a high initial percentage of sulphur, the undesirable limit will be sooner reached.

Mr. Speller rejoined that men who have had a great deal of experience in tube welding will not get into trouble from the overheating of the body tube, even if it is not allowed to cool before the safe end is heated with it. He said that the analyses indicate that the sul-

phur on the surface of tube heads reaches a maximum independent of the original sulphur contents. The cases of burning that he had seen were where the tube is burned back on the body tube, rather than right at the weld, in consequence of the body tube being hotter to start with, reaching too high a temperature before the safe end attained the welding heat.

Angus Sinclair said that he remembered locomotives with 6-foot tubes, and had seen them grow to 22 feet, and could not remember any time when there was not trouble from leaky tubes. He thought that the greater part of the trouble came from gross negligence in handling the engines, although there is no doubt that inferior material has been used for tube purposes to some extent. In Scotland they had nothing but brass tubes, but they had the same trouble. The man on the dumping pit is the fellow who causes most of the leaky tubes. He told how he got along very nicely with an engine which had a bad reputation, by being careful with the feeding and firing, always bringing the engine in with plenty of water, closing the dampers as soon as the fire was out and keeping the cold air from running through. When a blower is put on after the fire is out, it is "beyond nature" that the engine should keep from leaking.

Mr. Redding said that in the later-day service the fireboxes are so big, and the demands for steam so great, that they had to fire with the fireboxes wide open. The ash pans do not have dampers any more, and after the engine starts for the roundhouse there is no reason why the cold air cannot get to the tubes. Tubes are necessarily cooled down very quickly after the fires are out.

A gentleman present stated that cases are frequently cited where steel has been subjected to a few hours' test with acid and reduced perhaps 40 or 50 per cent., wrought iron a little less, and the so-called ingot iron showed no depreciation whatever. If this were a fair test, it would indicate that we should return to the old wrought iron, but the speaker doubted the fairness of the test. He said that they were building quite a number of power houses, and for the smokestacks had used different kinds of metal with a view of ascertaining which would best resist corrosion. They had something like sixty power houses and were now using open-hearth steel, his people considering it the most economical, for the reason that when they specified wrought iron, they paid for wrought iron and got steel anyway. They did, however, use charcoal iron for safe ends for tubes, because they felt that they got a little better weld between the charcoal wrought iron and the steel tubes than they did with steel safe ends.

Mr. Speller replied that a committee of the American Society for Testing Materials had gone into this subject very thoroughly, and their verdict, in which they say that the acid test is unreliable and misleading, will be found in the *Proceedings* of that society for 1908 or 1909. The reason is that there is no comparison between the action of acid solutions and natural corrosion. The very pure iron that the speaker referred to as having stood the acid test is open-hearth steel refined to the very last point, so that it may contain as high as 99½ per cent. iron. So far the indications are that ordinary soft steel, if properly made, will stand up just as well, but it will be some time before we have enough tests to actually prove that point. They felt that steel especially made for welding is as good as anything procurable at present. They had watched this point for several years. The usual method of testing was to compare a set of tubes of one material with another in the same engine. They would then duplicate them and reverse the position in the engine. Sometimes railroad men preferred to take several engines and put several sets of tubes in. They had made tests on at least twenty railroads, with the result that they had found very little difference between modern steel and charcoal iron.

Mr. Lovekin said that about ten years ago he had fitted six steamers that were built for the American-Hawaiian Steamship Company, with the Shelby cold-rolled steel tubes, and they have been running with both coal and oil fuel ever since, with no tube troubles. Since that time they have built about twenty steamships, all of them fitted with the Shelby tubes. The small amount of trouble experienced in marine practice as compared with locomotive practice might be due to the fact that the marine men do not cool and heat up their boilers as the railroad people do. In a ship a fire is kept up continuously, sometimes for sixty days. With an oil-fired furnace no cold air enters; the temperature is much more uniform and the conditions more favorable. On the other hand, they had had trouble in their power houses and blamed it on the steel tubes (feed pipes?) which had rusted out in six years. They now have wrought-iron tubes and do not know whether they will last six years or not. He thought that the trouble was from air in the feed line. He asked Mr. Speller to explain what was meant by a Spellerized tube.

Mr. Speller replied that five or six years ago they started to study the question of corrosion in all its phases, and found that the amount of forging and working which steel received was a factor that had much to do with the durability of the material, so they got up a process, which has become known by the name referred to. It has a decidedly beneficial effect, but it is not the only thing by any means. Care must be taken in the making of the steel itself. They found that the lap-welded steel tubes so made will stand up at least as well as the best charcoal iron.

Doctor Unger said that the two points which had impressed him in listening to the paper and the discussion were—how easy it is for the user to destroy material that was initially good, and how easy it is for the purchaser to insist on specifications that do not have any value. Anybody who is interested in the question of corrosion can find a full discussion of experiments in the *Proceedings* of the Iron and Steel Institute for 1908. This fact, not previously known to metallurgists, was found: If iron or steel is heated to about what we call a blue heat, or approximately a temperature at which lead would melt, it would be corroded much more quickly than if quenched from a higher to a lower temperature. It is easy to see how one in welding tubes may get a condition such as that described.

We know that our water supply is becoming much more impure. On account of the coal developments the water has become much polluted, and it frequently happens that we have in the Monongahela river as much as seventy parts of sulphuric acid to a million of water. This means that the plant to treat this water requires a great deal of salts, and by an analysis of the water used in the boiler we frequently find that we are trying to make steam from what one might call a solution of brine.

The air in Pittsburg one hundred years ago was much more pure than at the present time. Vegetation is disappearing. We are filling the air with poisonous gases, with the consequence that roofs made of iron and steel will not last as long as formerly. You all know that the tinplate made years ago was very much better than today. The same is said of galvanized materials. He also understood that steamfitters must not use anything but wrought-iron pipes, especially if they go through ash piles, because they will be corroded very much quicker. "There is nothing lasts like old-fashioned wrought iron." They had taken locomotives and put some steel tubes and wrought-iron tubes in them, and after about three years the wrought-iron tubes were removed and found to be badly corroded and pitted and would not hold steam any longer, while the steel tubes put in in the same way and at the same time were in good condition. In order to satisfy himself on this question he had been carrying on experiments for three or four years by immersing wrought-iron and steel tubes for a period of a year, and then removing and cleaning them to learn the results. They afterward placed both wrought-iron and steel tubes in an ash pile for fifteen months, and had them removed and cleaned. They now have tubes buried in loam, and expect to allow them to

remain there for two years to see what the effect will be. They had a number of sheets of various material, bessemer steel, two grades, open-hearth steel and three grades of wrought iron. They cut small pieces of these sheets and gave them what is known as the acid test. In one case a good grade of wrought iron dissolved 30 per cent. slower in acid than did the steel, but he found that the iron that had dissolved so slowly in acid did not resist atmospheric influences by one-half as well as the steel sheet. The only real test of corrosion today is an exposure test under service conditions.

Mr. Conrad said that corrosion is due, not only to impurities in the water, but to expansion and poor circulation and low temperature in the boiler. It has been his experience on modern locomotives, with tubes 20 feet and over in length, that the tube corroded mostly from the front tube sheet back about 4 feet. His conclusion was that this was due to the fact that the circulation was poorer at the front end of the boiler than further back, and the temperature lower. Dissolved oxygen and gases will attack iron at a low much more quickly than at a higher temperature. On one case, where an engine had run 101,000 miles with both iron and steel tubes, there were forty-six iron against fourteen steel tubes that were pitted badly enough to be consigned to the scrap pile. On three other engines, which had made a mileage of 62,000 miles, when laid up for general repairs the iron and steel tubes with which they were fitted had stood up equally well. Some years ago they had had trouble with corrosion in condensers and had tried a number of different kinds of tubes. They finally settled upon a brass tube, which resisted corrosion very well, but the bottom of the condenser would have holes eaten into it. They came to the conclusion that it was due to poor circulation, and overcame it by entering the steam at the bottom. He found that in certain cases tubes had been spaced too closely, impairing the circulation and producing trouble. This is especially true of an alkali water, which has a tendency to pull away from the hot sheets. He had seen this demonstrated by a model boiler with ¼-inch tubes, filled with an alkali water, and heated by alcohol. When the water began to circulate and the fire became intense, the water frequently left the sheet, but only momentarily. This, of course, had a tendency to loosen the tube in the sheet.

A speaker said that they had been using steel tubes for about twelve years in districts that had very bad water. They used steel safe ends, with the seamless tubes. In heating for welding in the safe ends they do not depend upon swedging the tube, but ream it, thus giving a bright surface. They also cut off the safe ends with dies, which gives two bright surfaces of new metal to come together for welding. Their tubes are tested by hydraulic pressure up to about 300 pounds, and seldom develop a leak. It does not matter what kind of a tube you buy, if it is not given proper care. In applying their tubes at first they used a roller, but are using it very little now. At the roundhouse the rolls have been thrown away entirely.

It was stated that the superintendent of motive power on one of the railroad systems had reduced their boiler troubles to a minimum by carrying 10 per cent. below the pressure of steam allowed; that is, on boilers which were allowed 200 pounds, they carried only 180, and the question was raised as to why it would not be well to extend this practice to the railroads which were having boiler difficulties.

Mr. Redding replied that they need every ounce of power that they can get. He had tried both iron and steel tubes and found that the steel safe ends and the steel tubes would stand more punishment. On engines which do not receive very severe treatment they frequently have tubes that last too long, for some of the State laws require that they be removed every three years.

Mr. Lovekin asked what was the use of the copper ferrule between the tube and tube sheet. He said that he had visited the works of the Babcock & Wilcox Company abroad, and their manager said that they had very little trouble with tubes, as they reamed all of the holes and ground every tube, allowing no more than 0.005 clearance between the tubes and the aperture.

Mr. Conrad explained that the reason for the use of the copper ferrule is that that material is much softer and has a greater coefficient of expansion than iron. It helps to make a joint and cushions the tube, maintaining the tube tighter. He has known of a case where orders have been given on a railroad to extend the copper the same length that they would the tube, with the consequence that the tube was entirely away from the sheet, but the expansion of the copper under the bead was disastrous.

That the purchase of coal on specifications needs to be followed up with analyses of the deliveries has been amusingly demonstrated by the recent experience of a Massachusetts city. The school board of this city has for some time been buying coal for the school houses on specification, but only recently did it take any steps to see whether it was actually getting the quality it was paying for. Lately it has made the first analysis of the coal delivered to it, and discovered that the coal was below the stipulated quality. As a result of this analysis, costing $10, the coal dealer has paid to the city a rebate at $873.01.

Sampling Coal

Following are the specifications for sampling coal as prepared by Arthur D. Little, Incorporated, chemists and engineers, of Boston. By this process the final sample is fairly representative of the entire shipment:

The original sample should preferably be collected in a large receptacle with the cover attached, by taking small shovelfuls from many parts of the car, barge or vessel as it is being unloaded, or from as nearly all parts of a pile as possible, care being taken in all cases to secure practically the same amounts from the top, middle and bottom of the coal. The original sample thus taken should amount to 500 pounds or more, preferably 1000 to 2000 pounds. A separate sample should be taken from each thousand tons or less delivered.

The gross sample thus collected should contain the same proportion of lump and fine coal as exists in the whole shipment. It should be protected from the weather in order to avoid gain or loss in moisture and should be immediately quartered down to a smaller sample, according to the following method:

The large lumps of coal and impurities should be broken down on a clean, hard, dry floor with a suitable maul or sledge, and after being thoroughly mixed, should be formed in a conical pile. The pile is then quartered, the two opposite quarters are rejected and the remaining two broken down to a smaller size, mixed and reformed in a conical pile and quartered as before. This process should be continued until the lumps are ¼ inch in size or smaller and a one- or two-quart final sample remains. All of this final sample should be placed immediately in one or more glass or metal jars and sealed air tight. The following table gives the largest sizes allowable in the samples of various weights and the coal should preferably be broken into still smaller sizes before quartering:

Weight of Sample	Should Pass Through
1000 pounds or over	1½-inch sieve
500 pounds	1¼-inch sieve
250 pounds	1 -inch sieve
125 pounds	¾-inch sieve
60 pounds	½-inch sieve
10 pounds	¼-inch sieve

The sample should be worked down as rapidly as possible to avoid loss of moisture through exposure to the air. The outside of the jar should be plainly marked and a corresponding description placed inside. The following data should accompany the sample:

Coal delivered to .....
Sampled by..... Date .....
Amount taken for original sample.....
Amount of coal sample represents.....
Sampled from barge, car or pile.....
Car (initial and number).....
Barge or vessel.....
Trade name of coal .....
Grade (¾, slack, nut, run of mine, etc.).....
Remarks (appearance of coal, lumps, slate, sulphur balls, weather conditions, etc.).....
Sold by.....Mined by.....
County.....State.....Mine.....

Electrical Department

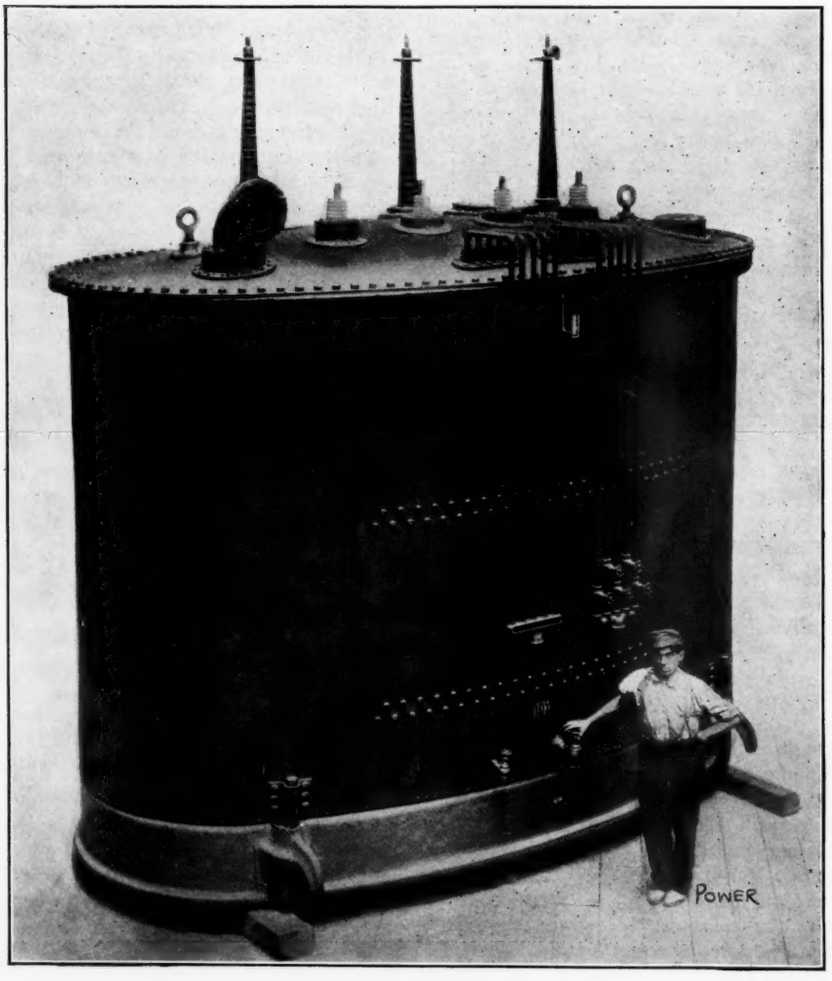
Especially conducted to be of interest and service to the men in charge of the electrical equipment

A Large Transformer

The Pennsylvania Water and Power Company generates power from the Susquehanna river at McCall's Ferry, where it will have an ultimate capacity estimated at 100,000 kilowatts. At present the power generated is transmitted 40 miles to Baltimore, and lines to other large cities, of which there are several within economical transmission distance, are contemplated.

The Baltimore substation at present contains four Westinghouse three-phase transformers which are interesting because they are the largest ever built. They are of the water-cooled shell type and are used to step down the 25-cycle line currents from 70,000 to 13,200 volts for primary distribution. Each transformer is rated at 10,000 kilovolt-amperes. The appearance of one of these transformers is shown in the accompanying picture, but this does not give an adequate impression of their size. The tank is elliptical, having an overall length of 15 feet 11 inches and an overall width of 8 feet 8 inches. The hight to the tops of the terminals is over 16 feet and the joint between the tank and the cover is 11½ feet from the floor. The weight of each transformer, complete with oil, is about 145,000 pounds—nearly 75 tons.

It is difficult to get a mental grasp of the magnitude of such a piece of apparatus. If the output of one of these transformers were delivered to 16-candlepower tungsten lamps, it would supply 500,000 of them; these lamps laid end to end would form a "string" 31½ miles long. If suspended at intervals of 10½ feet, they would illuminate a pathway a thousand miles long. Using arc lamps instead of incandescents, one transformer would supply 25,000 lamps and these would illuminate a boulevard 100 feet wide, reaching from New York City to Toledo, O., or from Chicago to Memphis, Tenn.



A 10,000 KILOVOLT-AMPERE TRANSFORMER

Grooving Commutators

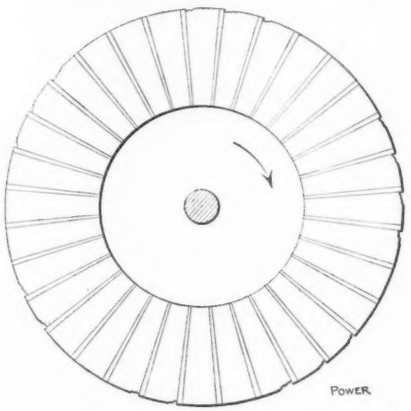
BY C. L. GREER

It has for some time been a practice in street-railway shops to groove or undercut the commutators of car motors but the practice does not seem to have spread extensively to power-station apparatus. From my own experience I believe that this practice would be helpful in many cases of commutator trouble with generators and rotary converters. Where there is a tendency to high mica, the undercutting of the commutator (cutting the mica below the surface of the copper bars) will greatly reduce and sometimes completely eliminate sparking at the brushes. I know of a 300-kilowatt motor-generator set which gave continuous trouble from sparking, making frequent turning of the commutator necessary. After grooving the commutator the machine ran sparklessly and the commutator took on the chocolate-colored polish which follows perfect commutation.

I once had the care of a 250-kilowatt three-phase rotary converter which gave continuous trouble from sparking at the brushes. The commutator developed burned blackened spots at irregular intervals around its circumference. In some places six or eight bars were affected and in others only two or three were burned. The accompanying sketch illustrates the results of the trouble. The bar burned away from the mica, with bad sparking at the brush as the bar passed from under it. This kept the commutator very rough, making frequent use of the

sand-paper block necessary. Finally it was decided to groove the mica out at the bad places, after which there was a decided improvement.

Where no special means is provided for grooving, the work may be done with a hack-saw blade. A new blade should be broken, which leaves a sharp tooth on the broken end of one piece; with this the mica may be cut down easily. A straight-



EFFECTS OF HIGH MICA

edge may be laid along the mica and the blade drawn along between the bars. One or two strokes will produce a groove which the blade will follow easily. Only a slight depression is necessary; I have found a sixty-fourth of an inch to be sufficient. If, as in the case of my rotary converter, the trouble occurs in spots, the bad bars may be marked on the end before turning the commutator and only the mica at the bad spots cut down. Though my experience with this remedy has been limited, I believe that it is worth trying where sparking and burning of the bars occur.

Alternators for Waterwheel Drive

Alternators direct-coupled to waterwheels operating under such heads as are common in modern hydroelectric power plants run at relatively high speeds and operate under conditions which make rugged construction necessary. Hence one finds machines built especially for this class of service. In general features the waterwheel-driven alternator does not differ from its prototype driven by a large reciprocating steam engine; the chief differences are in mechanical construction.

Fig. 1 illustrates a polyphase alternator built by the General Electric Company for use in hydraulic stations. The picture shows clearly that the shaft and bearings are exceptionally massive; that the shaft and base are made extra long, to permit sliding the stationary armature along the base far enough to uncover

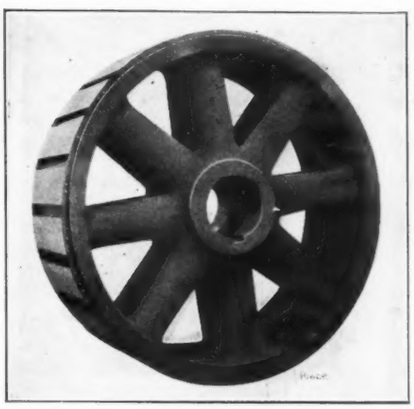


FIG. 2. FIELD-MAGNET SPIDER

the revolving field magnet, and that the exciter is driven directly from the end of the alternator shaft and, therefore, at alternator speed.

The spider on which the field-magnet poles are mounted is also very massive, as indicated by Fig. 2, and the poles are attached to the rim of the spider by dovetail projections fitting snugly in corresponding slots across the face of the spider. The poles are prevented from shifting in their slots by end rings bolted to the edges of the spider; these are shown in position in Fig. 2. The poles are laminated and the laminations are bolted together between heavy cheeks, as shown in Fig. 3. The free ends of the poles are stamped with extensions, or poletips, as usual, and the cheeks cover the polar extensions and are provided with flanges which support the ends of the coils.

The armature core is built up of circular segments with the joints staggered in successive layers, as usual in large

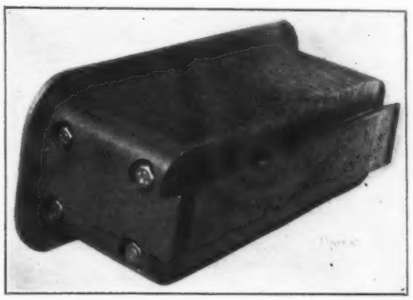


FIG. 3. FIELD-MAGNET POLE

sizes, and these are dovetailed to ribs across the inner face of the housing in exactly the same way that the magnet poles are dovetailed to the spider rim. Fig. 4 shows this construction and also shows a simple bolted-on type of magnet pole that is used in alternators which run at sufficiently low speeds not to require the dovetail fastening. The armature housing is ventilated by openings through the main ring and by spaces behind and at the sides of the armature core, as illustrated in Fig. 5. The core

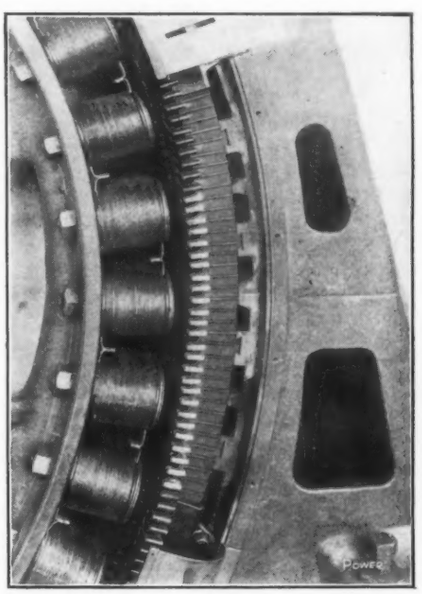


FIG. 4. SEGMENT OF ARMATURE

and coils are ventilated by the usual spaces or radial ducts at intervals in the core body; ten of these spaces are provided in the core here illustrated.

When the armature winding is a heavy one, the projecting ends are secured to

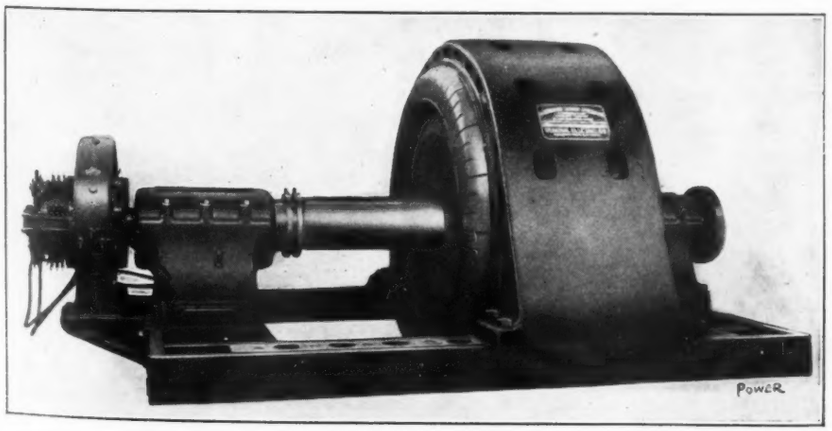


FIG. 1. ALTERNATOR FOR DIRECT DRIVE BY WATERWHEEL

insulated metal rings in order to prevent accidental displacement or distortion due to magnetic disturbances produced by violent load fluctuations. Both the field-magnet and armature coils are form-wound and heavily insulated, of course, before being put in place.

The bearings are self-oiling and in the larger sizes provision is made for water-

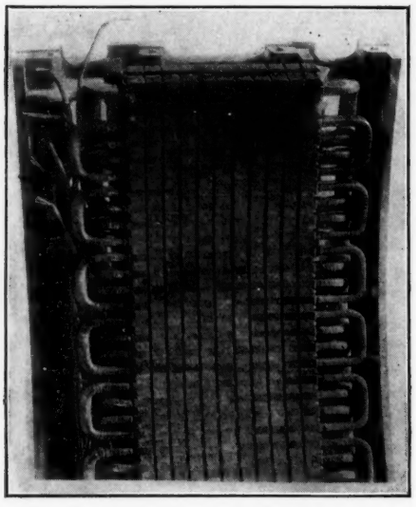


FIG. 5. PART OF ARMATURE FACE

cooling by means of tubes extending horizontally through the oil wells; the cooling water is circulated through these tubes and takes out the heat from the oil.

CORRESPONDENCE

Trouble with Series Incandescent Lamps

We had a little experience with a lamp on a series circuit which, although not exactly in the usual operating engineer's line, may prove of interest to plant operators in smaller places who have more or less to do with the outside distributing system.

Our street circuit contains 67 series incandescent lamps of 32 candlepower each, supplied with a constant current of 6.6 amperes controlled by a reactive regulator. We added one new lamp to the circuit and on the first night it burned out. It was replaced the next day and the burned-out lamp was found to have a hole burned in the glass, but not much importance was ascribed to this fact. The next night the operation was repeated and the damaged lamp was found in the same condition as the first one. This appeared strange, as in a series system all the lamps get the same current and it was not reasonable to suppose that a lamp at any particular point could receive any more current than the others.

Our next move was to take one of the old lamps from another point in the system, and try it at this point; it worked perfectly. We next put in a new lamp and it burned out in less than five minutes; it looked like a defective lamp, but we decided to investigate elsewhere before trying any more lamps. An examination at the station showed that the circuit was getting a little more than 7 amperes. The regulator was adjusted to pass exactly 6.6 amperes and another new lamp was put in; after that no more trouble was experienced. That was more than six months ago and we have added a number of new lamps since but have had no more trouble with burnouts.

By way of explanation, there had been no new lamps added to the system for some time previous to the trouble and it was known that the regulator could not have been out of adjustment for any great length of time.

Can anyone explain why the new lamps would not stand the excessive current and the old ones would?

G. S. SPRAGUE.

Geneva, Neb.

Mr. Wilbraham's Interpole Motor Trouble

I found Mr. Wilbraham's article of March 28 concerning brush setting on interpole motors very interesting, but cannot in all respects agree with his conclusions. He states that he had compound-wound interpole machines arranged for variable speed by means of a combined armature and field controller and that after cutting out all armature resistance the speed was 800 revolutions per minute, which by field weakening could be increased to 2800 revolutions per minute, but some of the motors at about 2600 revolutions per minute would stop and reverse.

While the armature reaction and flux distortion are more or less as he outlines them, the fact that the motor stops and reverses is not due to a shifting of the neutral point and with it the zone of commutation but to the fact that the compound winding is differential rather than cumulative. As the magnetism due to the current in the series winding is maximum and that due to the shunt field current constantly decreases as the field is weakened, the final result is reversal of the polarity of the field-magnet poles and consequent reversal of the direction of rotation. Now if the series field winding were so connected that it assisted the shunt field winding instead of opposing it, the action described could not take place. Changing the direction of the current in the series winding is, therefore, to my mind the correct remedy rather than shifting the brushes.

It is primarily an error to buy a compound-wound interpole motor, for several reasons. Trouble may be caused by it, as already shown, and the compounding adds uselessly to the cost. The series winding on the interpoles of a shunt-wound motor will serve the same purpose as a main series winding; therefore, a main series winding in addition to this represents a duplication of equipment subserving no desirable end.

H. T. DEAN.

Cambridge, Mass.

Mr. Dean's idea as to the prevention of the reversal of the motors by changing the series field windings from differential to cumulative is correct; that was tried at the time but the commutation was so much worse that it was abandoned. Moreover, preventing the motors from reversing was not the only thing to be considered; the guarantees as to speeds at different points had to be met and with the series field winding connected cumulatively the magnetic densities were so high that a greater range of shunt field adjustment was necessary to effect the range of actual field strength that was necessary. For this reason, as well as because of the impaired commutation, the remedy used was the only one that was practical under the operating conditions.

Mr. Dean's supposition that the interpole winding serves the same purpose as the series winding of a compound-wound machine is entirely wrong. The interpole winding adds no torque or counter electromotive force whatever to the armature; a shunt-wound interpole motor will have the same sort of speed characteristic as the ordinary shunt-wound motor, except that the speed regulation will not be so good because of the additional resistance of the interpole winding in series with the armature. It is to correct this poor regulation that a differential field winding is used. The only use of the interpoles is to give good commutation under conditions which would cause sparking in an ordinary motor and this is done by inducing in the coils that are short-circuited by the brushes an e.m.f. which reverses the current in those coils and thereby prepares them for insertion in series with the coils beyond them. The interpoles exert no influence upon the coils that are not short-circuited and these are the coils that do the work.

R. W. WILBRAHAM.

Philadelphia, Penn.

[The delay in printing the foregoing letters was due to our inability to reach Mr. Wilbraham, who was absent from his office.—EDITOR.]

Bill Grimes tried t' get funny tother day an' put wun over on yer Uncle Si; he didn't get anythin' on me so ez it cud be notised very much. He called me up an' sed he'd lost th' vacuum on his condenser, an' ast me ef I'd loan 'im wun. I told 'im ter use th' wun he carried in his hed.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

A Reversing Marine Diesel Engine*

By Th. Saiuberlich

The prejudice against Diesel motors which still exists in shipbuilding circles has to a great extent broken down, and recently it has become clear that various shipyards are in position to build Diesel engines free from faults and reliable in working, even with their present equipment.

Hitherto the Diesel engine has been made almost exclusively single-acting. As a rule, the four-stroke cycle has been used, but recently the two-stroke cycle has come into prominence. The efforts to utilize the Diesel engine for large stations and finally for the propulsion of large vessels have given an impetus to the employment of double-acting engines both on the four-stroke and two-stroke cycles. In fact, leading ship owners, having recognized the great value of internal-combustion engines, are already approaching shipbuilders with orders involving their use.

The constructor is now confronted with the task of giving to the Diesel engine the reliability in working and capacity for manœuvering which distinguish the marine steam engine, and further, in consequence of the absence of steam supply, to find gear simple enough in handling and maintenance to suit the rough requirements of a ship's auxiliaries.

The advantages of the Diesel engine for marine purposes as compared with the steam engine differ according to the type of ship and the size of the equipment, but in general the following are among the most notable: The gain in useful space by the reduction [elimination?] of boiler equipment and small size of the fuel holders; increased capacity due to the small weight of the engines and the fuel; utmost utilization of the otherwise limited useful space taken for fuel bunkers; gain in time, and economy of wages, due to quicker and easier bunkering, and also to decrease in coal trimming; quicker starting of the engine; reduced and easier management; wages and space economy by reduction of the number of the stokers; reduced cost of fuel; cooler engine rooms, resulting in the increased mechanical capacity of the personnel, especially in hot climates; the possibility of carrying more fuel, and therefore enlarged field of action.

But the introduction of Diesel marine engines also involves the solution of recent economic and constructional problems, of which the chief are the lack of suitable fuel in many harbors and the lack of steam for actuating the auxiliary engines on deck and in the engine room, as well as for heating.

The engine here described is the first marine Diesel engine built according to special design and put into service by a shipyard on the North Sea—J. Frerichs & Co., in Osterholz-Scharmbeck and Einswarden. It is a reversing four-cylinder engine of 200 horsepower, installed in the service boat "Frerichs," which is a single-screw vessel. She has been in commission about a year, doing towing principally, but also serving occasionally for transportation between Einswarden shipyard and the opposite bank of the Weser. The fuel employed is the so called gas-oil, 1000 kilograms (2200 pounds) of which are stored in two tanks under the cabin; double this quantity can, however, be carried. This quantity of fuel is sufficient for a voyage of 240 sea miles at 9½ knots.

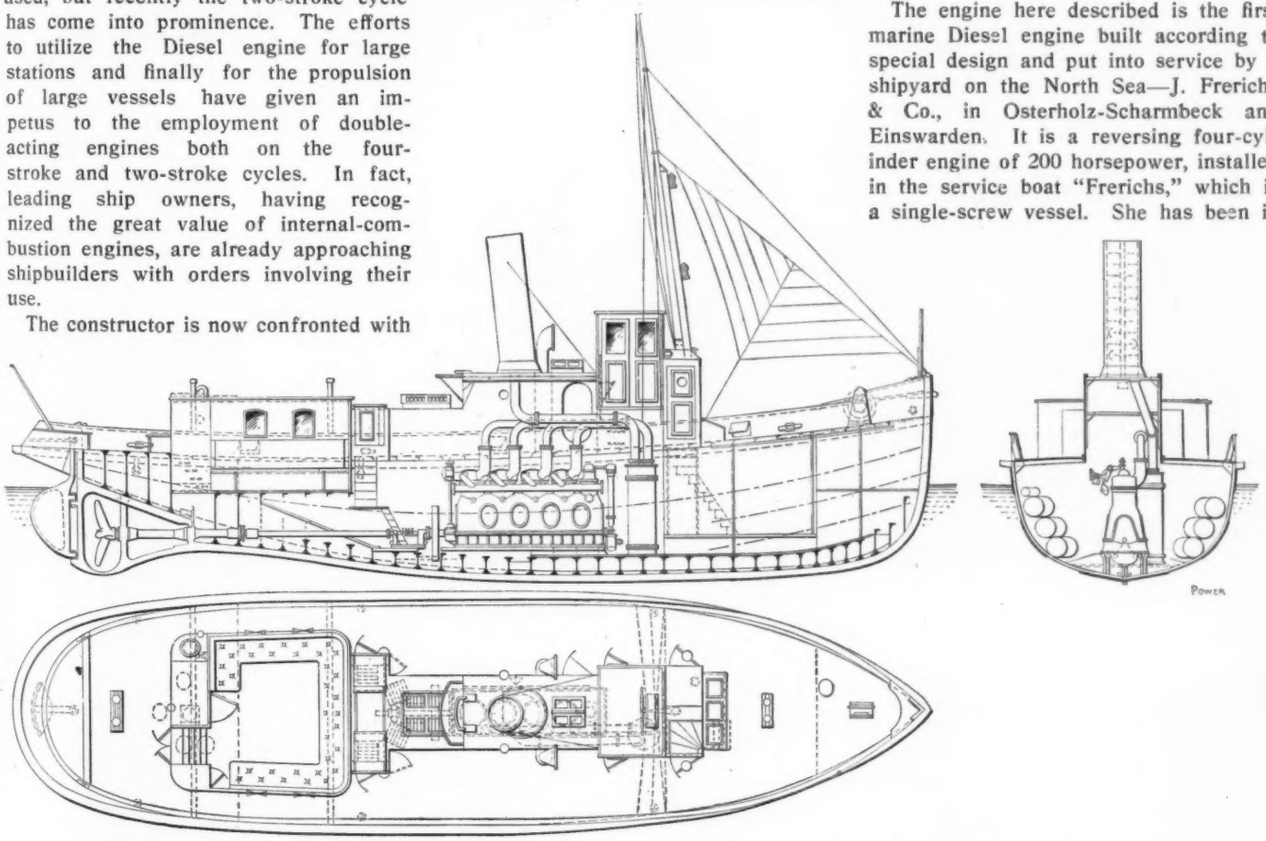


Fig. 1. Showing Arrangement of Diesel Engine Equipment in the "Frerichs"

*Abstract of a paper recently read before the Schiffbautechnische-Gesellschaft (Technical Shipbuilders' Association), Germany.

The external appearance of the vessel is similar to that of a steam tug, because of the funnel provided for carrying away the exhaust gases.

Fig. 1 shows the arrangement of the power plant in the vessel and Fig. 2 gives an excellent idea of the appearance of the engine. It operates on the four-stroke cycle and the maximum speed is 360 revolutions per minute; at this speed it develops 200 brake horsepower—50 horsepower per cylinder—and drives the vessel at a speed of about 10 knots.

The cylinder head is the largest and heaviest casting in the engine, and on it are collected all the principal valves—the suction valve, the exhaust valve, the starting valve and the fuel valve. All these parts have to be got into a restricted area little bigger than the piston diameter, and yet to avoid unequal thicknesses of metal reasonable spaces must be left between the separate parts. This arrangement is also necessary to insure equal cooling and to avoid stresses being set up by unequal heating. Furthermore, an exceedingly sound casting is absolutely essential, particularly at the joints and valve faces and at those surfaces subjected to the high internal pressure in the cylinder or connected with the high-pressure air supply.

Fig. 3 indicates how all these requirements were met. As may be seen from the engraving, the suction and exhaust bends are separated from the two tubes or passages which take the starting and fuel valves. The exhaust bend is entirely surrounded by water and is of such a shape as to give an easy flow to the gases. The exhaust and admission valves seat direct on the cover, for in no other way was it possible to bring them so close together.

It may be objected to this arrangement that dismantling is more difficult than when separate valve cages are employed, as it involves the removal of the whole cylinder head, but in engines of this size no trouble in this direction has been experienced. The only real objection is that that part of the valve spindle exposed to the hot gases may wear more rapidly than the remainder, which is water cooled, but to reduce this objection the lower part of the spindle is protected by a cone from the direct impact of the hot gases. In the case of larger valves the employment of a liner is, of course, recommended. In order to make the cooling as effective as possible, the walls are made only ½ inch thick.

The reversing gear of the engine is based on the principle of shifting the cam shaft, on which two separate sets of cams are fashioned, endwise, the valve levers being raised just before this movement takes place and lowered again when it is complete. These movements are effected in the following way by the use of a single handwheel: The shaft *a*, Fig. 4, passes over all the cylinder heads, being carried by the columns *b*, of which there are two mounted on each head. To this shaft are keyed the fingers *c*, one over each exhaust and inlet valve, and the lever *d*, linked by *e* to the curved lever *f*, which, in turn, is linked to the piston rod of the reversing cylinder; the latter has pipe connections *g* and *h* extending to the valve box beneath the handwheel. Here either valve can be released by movement of the ⊥ lever *l*, which is effected by one end or the other of the notched quadrant *n* coming into contact with it; this quadrant is keyed to the handwheel shaft. The valve being opened, further movement of the plate releases the lever and the valve again closes. Owing to the form of the quadrant *n* and the notches in the quadrant *p*, this movement can only be effected in the central position *II*.

In Fig. 5 is shown a sector *T* which is provided with the cam face which moves the lever *B*, and thus moves the reversing cam shaft *N* endwise. The sector is coupled, by the link shown, to the shaft *w*.

The action of the reversing gear will now be easily understood. The hand wheel is moved to the middle position and is then revolved till the stop *r* on the notched quadrant comes against the quadrant *p* and stops further movement. During this action the valve *i* would be opened for a short time, allowing compressed air to get under the piston *k*, forcing it up. This causes movement of the linkage and presses the valves down into the cylinder. When they have reached their lowest position the action of the cam *T* moves the cam shaft endwise. By that time the piston *k* has returned to its starting position, lowering the valve rockers on to the second set of cams. The glycerin dashpot acts as a brake to prevent reversal taking place too violently.

Provision for lifting the rocker arms of the starting and fuel valves off their cams is effected, as indicated in Fig. 6, by mounting the respective rockers on eccentrics keyed to the shaft *w*. By turning the sleeve, the fuel-valve lever moves away from its cam while the starting-valve lever approaches its own cam; in this position both levers are clear of their cams and the shaft can be moved end-

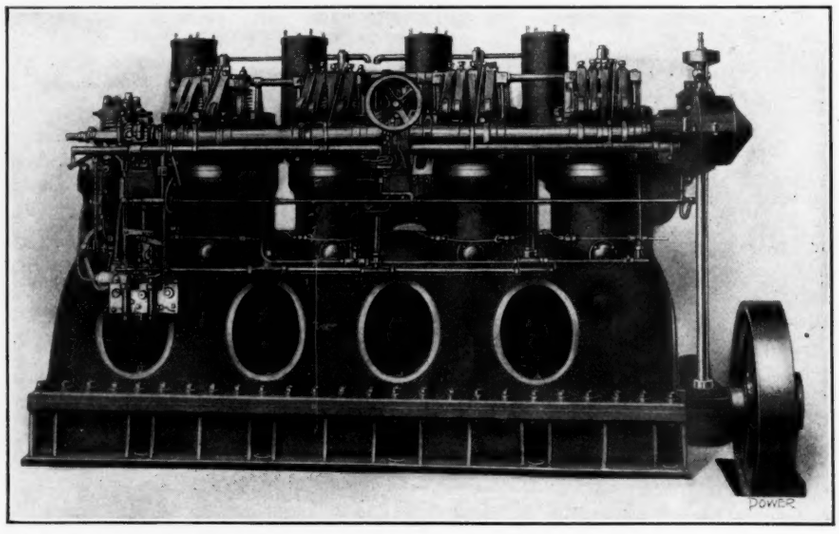


FIG. 2. A 200-HORSEPOWER REVERSING MARINE DIESEL ENGINE

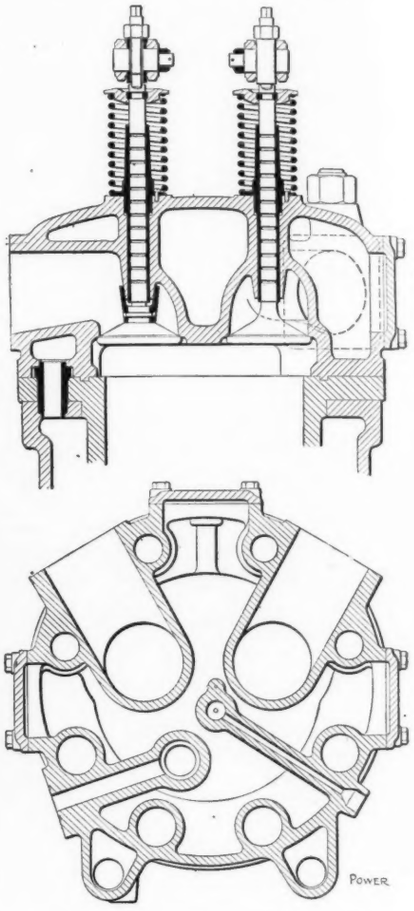
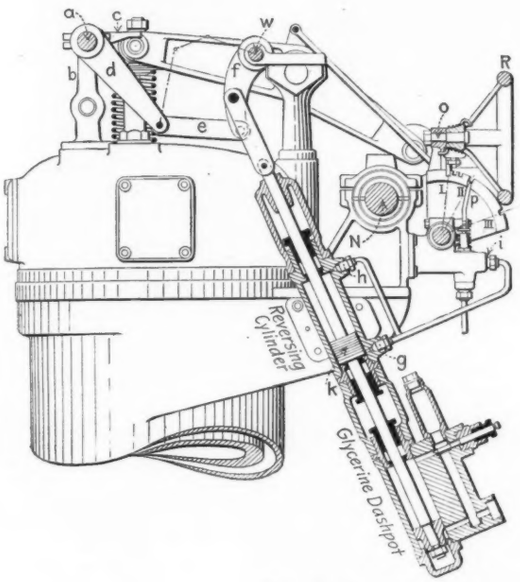


FIG. 3. CYLINDER-HEAD SECTIONS

wise. By further movement to the starting position, the fuel-valve lever leaves its cam while the starting-valve lever comes into actual contact with its own.



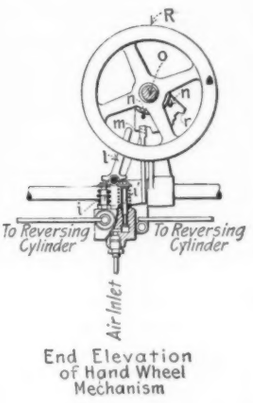


FIG. 4. REVERSING MECHANISM

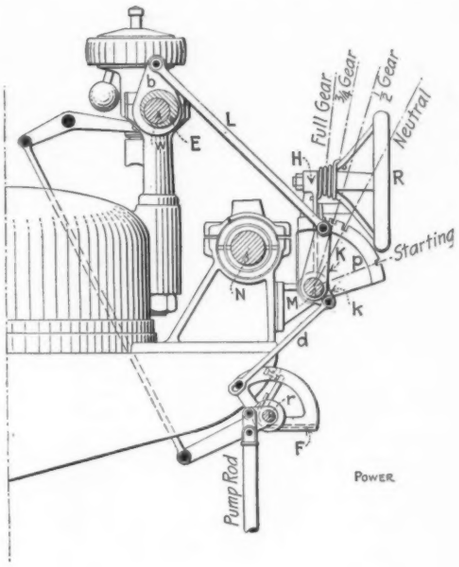


FIG. 7. REVERSE-GEAR DETAILS

Rotation is given to the eccentric sleeve by means of the mechanism shown in Fig. 7, from which it will be seen that it is coupled by the rod *L* to the shaft *M*, to which is also keyed the hand-wheel bracket *H*. This bracket, with the hand wheel, can be moved to three principal positions on the notched quadrant *p*: the first for running, the second neutral and the third or lowest for starting. Further notches for half and slow speeds are also provided. This control is effected through the link *d*, which acts upon the fuel-pump regulator rod. As the centrifugal governor also acts upon this rod, an elastic coupling in the form of a flat spring *F* is provided. The governor was originally provided for the test stand, but in view of the fact that the engine might run light it has been retained.

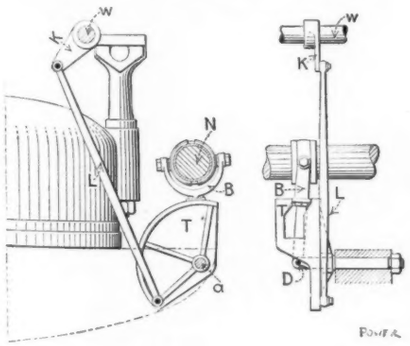


FIG. 5. CAM-SHAFT SHIFTING MECHANISM

The engine is started by means of compressed air and the compressor is a two-stage machine driven from the main shaft by a crank which is so set that when the engine cranks are on the dead center the compressor crank is not. Consequently, the compressor can be used as an air motor to start the engine even though the latter may stop on the center, which, however, is unlikely. Fig. 8 is a sectional elevation of the compressor. The low-pressure stage is double-acting and without suction valves, air being admitted by the piston overrunning a central port. On this low-pressure cylinder are placed the starting valves *A* and *B*, operated by the cams and links shown. This stage being double-acting, it is easy to arrange that it shall start in any position from which it is not possible for the power cylinders to start.

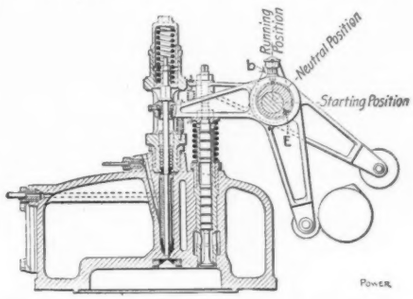


FIG. 6. AIR- AND OIL-VALVE MECHANISM

The lubrication of the gudgeon pins, which is always troublesome, is effected in this engine by the device shown by Fig. 9. The tube *A* on the piston at each outward stroke is driven into oil contained in the cup shown, some oil enters the tube and, being retained by the little ball valve, is driven up by the next descent of the tube.

It is not generally possible to obtain such good diagrams from high-speed as from low-speed engines, owing to the very short space of time in which combustion has to take place, but almost ideal diagrams, as shown in Fig. 10, are obtained from this one. The average pressure shown by this diagram is about eight atmospheres. The fuel consumption measured on the test bench to between 215 and 220 grams (7¾ ounces) per brake horsepower-hour.

The boat which is driven by the engine just described fully meets all the expecta-

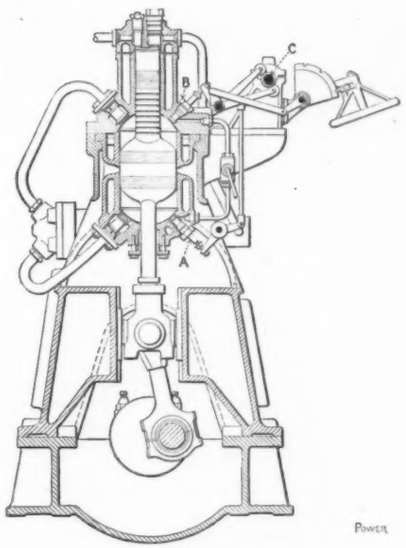


FIG. 8. AIR COMPRESSOR

tions formed of her as to manœuvering. The insurance companies have made exhaustive tests in this respect with a view to fixing the premiums payable and have satisfied themselves that the manœuvering capacity is equivalent to that of a

steamship; they have therefore made the premium the same as that customary for steamships. The maximum speed of the boat can be reduced, by regulating the engine, from about 10 miles to about 3.8 miles per hour, the revolutions of the engine being lowered from 360 per minute to about 150 per minute.

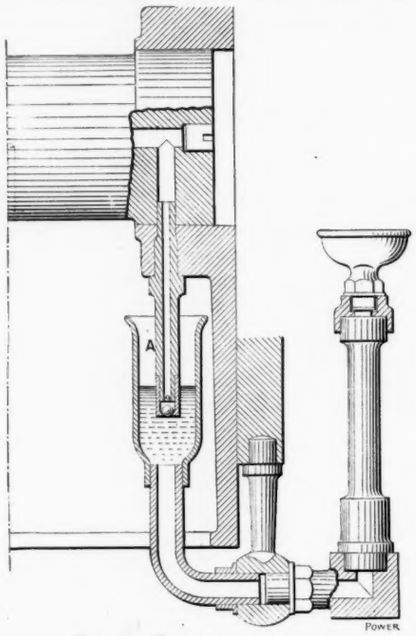


FIG. 9. GUDGEON-PIN OILER

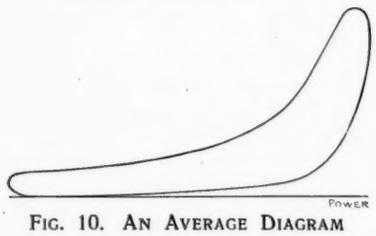


FIG. 10. AN AVERAGE DIAGRAM

Reversing is carried out with surprising celerity and smoothness. Tests carried out in comparison with similar ships with steam engines have given the results stated in the accompanying table.

RESULTS OF MANŒUVERING TESTS

	A Steam tug, L. 20.95 m., br. 4.86 m., d. 2.18 m. I.H.P. about 180; revs. about 185; reversing hand wheel.	B Motor tug "Frerichs," L. 18 m., br. 4.9 m., d. 2.00 m. I.H.P. about 185, revs. about 300; reversing hand wheel.
	Seconds	Seconds
1. Engine starts from rest, ahead, about.	4–5	2–5
Engine starts from rest, astern, about	4–5	2–5
Engine reverses, from beginning of motion, full forward to full astern.....	15	8
2. Beginning of boat's motion forward from rest.....	6	11
Beginning of boat's motion astern....	10	12
I. Boat comes to rest from full forward to full backward..	30	27
II. From rest to full speed astern.....	20	10

Comparison of Actual Gas Power and Central Station Figures

BY SAMUEL W. RUSHMORE

The central-station people have been urging us to use their service for our plant* having motors of a total rated capacity of 350 horsepower, at the following wholesale rates:

CENTRAL STATION RATE FOR 20,000 KILOWATT HOURS PER MONTH

Primary charge per month.....	$225.00
First 3,000 kw.-hours @ 3c.....	90.00
7,000 kw.-hours @ 2c.....	140.00
10,000 kw.-hours (or over) @ 1c. kw.-hr	100.00
Total per month at present load....	$555.00

As we are using producer gas for our japanning ovens, soldering-iron and annealing furnaces and blacksmith forge, if we adopted the central-station service we would be obliged to purchase about $125 worth of city gas per month, making the total cost of station service for our present load of 20,000 kilowatt-hours per month 3.9 cents per kilowatt-hour.

We therefore made a test run of one week, keeping the fuel bed in the producer at constant level and carefully weighing all coal used day and night. The switchboard watt-hour meter had been calibrated and found to be accurate a short time before; also, the water meter in the connection to the vaporizer. The producer is of our own construction, of the common suction type with a shaking grate; the fuel bed is 5 feet in diameter and carried 5 feet deep above the grate. The test was made with two single-cylinder horizontal Körting engines: one of 21¼-inch bore by 34½-inch stroke, rated 140 horsepower at 160 revolutions per minute, and the other of 19¼-inch bore by 31½-inch stroke, rated at 100 horsepower at 155 revolutions per minute. Business being rather slack, the total load was only about 180 horsepower but of a very steady character.

In addition to the engines there is a Sturtevant gas exhauster drawing the gas from the producer for the furnaces; this quantity is estimated at about 125,000 cubic feet during the week. The plant was operated nine hours a day for the first five days and four hours on Saturday. The total energy delivered from the switchboard was 5094 kilowatt-hours, with following operating costs:

Total pea coal consumed during the test, including all standby losses, 15,218 lb. @ $3.15 per ton.....	$21.51
7½ gallons cylinder oil @ 40c.....	3.00
5 gallons engine oil @ 25c.....	1.25
2 gallons kerosene @ 10c.....	0.20
8 lb. waste @ 10c.....	0.80
Wages, engineer and producer man....	33.00
Total.....	$59.76

*Manufacturing acetylene-gas search lamps.

According to these figures the average cost of labor and supplies was 1.17 cents per kilowatt-hour. If, however, we credit the plant with $30, which would otherwise be paid for city gas, the cost comes down to about 0.6 cent per kilowatt-hour. Of course, these figures do not include any fixed charges or repairs, but with liberal allowance for these items the cost directly chargeable to power would not be much over 1¼ cents per kilowatt-hour. Should we adopt the central-station power, we would not throw out the engine plant, so the comparison was made on actual operating cost.

In this particular plant the cost of repairs is practically negligible. The 100-horsepower engine has been in operation for about four years, often day and night, with no actual repairs. The large engine has been running for over a year with only the usual adjustments, costing about $10 per engine (average for two years) every sixty days. In two years the producer has required no repairs. We dump the fire only twice a year and point up the brickwork with carborundum cement. The producer had been in continuous service without dumping for three months prior to the test.

During the test the water meter showed that the vaporizer had taken 91 cubic feet of water, or about 0.38 pound of water per pound of coal. The water was all evaporated and passed through the fire. The gas was of good quality throughout and there was no trouble from clinkers. Noting the low water consumption and having been told that the proper ratio was 0.7, we tried to increase the water feed, but this seemed to impair the quality of the gas and the best results were obtained with the proportion stated.

In our plant the exhaust gas is passed through a special boiler from which we obtain about 150 pounds of steam per hour. Although this was not considered in the test it forms a valuable addition to our steam-heating plant and during the summer months when the heating boiler is shut down we use a large part of this steam for distilled water in our chemical work and for drinking in shop. The jacket water from the engine is passed through pipes buried in the cement floor of one of the buildings, making a further saving in coal for heating; all things considered, therefore, we believe we are producing our power at a cost, including all charges, of not much over 1 cent per kilowatt-hour.

To the quoted cost of central-station power must be added interest and depreciation on a $3000 investment for a motor-generator—about $25 per month—and at least $15 per month for attendance.

We have two producers, each rated at 200 horsepower, but up to 225-horsepower output we secure very satisfactory results with but one in service.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Some Test

Herewith are the results of a recent boiler test with which I do not agree.

In the first place, the test was started with what he designated as a "flying start," which consists of running the boiler to its utmost capacity for an hour, getting the walls white hot, then winging the fire back and forth on the grate several times and immediately starting to weigh water.

The first thing he did after starting was to rake all the coke and unburned coal from the ashpit that had been dropping through the grate bars during the preliminary run and put it on the fire, although it was not weighed and no record taken or allowance made. This performance was repeated three times during the nine hours' run.

The log of the test shows 121 weighings of water, 37 readings of feed-water temperature, 109 readings of steam-gage pressures and 17 readings of stack temperatures and drafts.

The accompanying table gives, first, the results of the test as a whole, and, second, the results for the first and the last half of the test as shown by the detailed log and by memoranda not forming a part of the official record.

The first reading of the steam pressure at the start was 132 pounds. The pressure kept going up until a maximum of 148 pounds was reached within the first 20 minutes and continued high for some time. The highest pressure recorded for the last hour of the run was 124 pounds, from which it gradually decreased until the finish of the test, when it was 93 pounds.

At the start there was a good, clear 8-inch fire and at the finish there was not enough fire to barely cover the grate; as was evidenced by the fact that it was dead out and the walls black in ten minutes after the draft was shut off and the test stopped. No new coal was used in the last thirty minutes, although the steam pressure was steadily falling; in fact, 32 pounds of coal was weighed back as not used.

I have been present at or have conducted many boiler tests, but I never yet have been able, by fair means, to increase the evaporation in the last half of a test and make it 9 per cent. better than in the first half when the fire was new and clean and the walls red hot from the preliminary run.

FRANK C. KNIGHT.

Bridgewater, Penn.

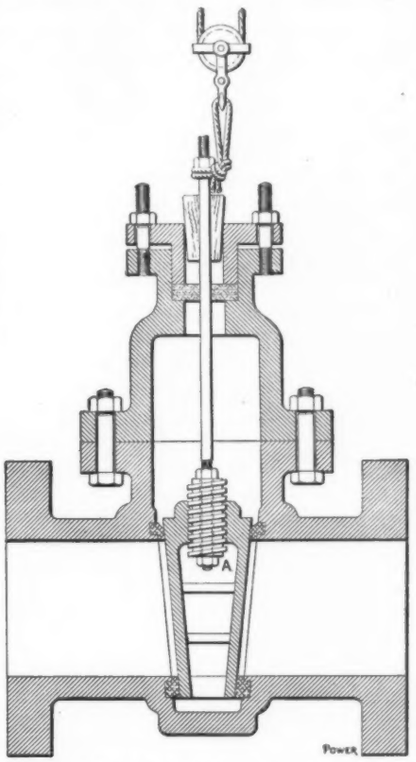
RECORD OF TEST MADE ON ONE HORIZONTAL RETURN TUBULAR BOILER 66 INCHES BY 20 FEET

	Whole Test	First Half	Last Half
		A.M.	P.M.
Duration of run, hours	9	4½	4½
Steam pressure (5-minute readings), pounds, gage	123.2	127.7	118.7
Feed-water temperature (15-minute readings), degrees Fahrenheit	116	116.5	115.5
Temperature stack gases (30-minute readings), degrees Fahrenheit	607	620	594
Draft in uptake (30-minute readings), inches of water	0.715	0.520	0.910
Draft over grate (30-minute readings), inches of water	0.443	0.273	0.613
Coal consumed (28 weighings), weight as fired, pounds	5,568	3,000	2,568
Coal consumed per hour, pounds	618.6	667	572
Water evaporated (121 weighings), pounds	46,556	24,078	22,478
Factor of evaporation	1.1446	1.145	1.144
Water evaporation per pound of coal as fired, pounds	8.36	8.02	8.75
Equivalent evaporation from and at 212 degrees, pounds	9.56	9.18	10.01
Commercial horsepower developed, horsepower	171.62	177.53	165.79
Coal burned per horsepower per hour, pounds	3.604	3.76	3.45

Operating a Broken Valve

A pumping engine was shut down in order to renew some rubber valves and make other minor repairs. When the work on this unit was completed the discharge valve was opened, and the pump was slowly started while the suction valve was being opened. The valve at first turned hard and then, all at once, turned easier than usual. It was thought at the time that the threads on the stem had worn down. So the gear wheels, packing box, gland and valve stem were removed and just below the collar it was found that the stem had twisted off, the result of an old fracture.

To get a new valve stem and cut threads on it would take some time. It was necessary, however, that the pump should be started as soon as possible for the water supply in reserve was decreasing while this unit was down. It was decided to open the valve with a tackle; a part



SHOWING HOW THE VALVE WAS REPAIRED AND OPERATED

of the threaded stem was cut off and a hole drilled through from end to end, for a threaded rod, so that a nut could be screwed on each side of the stem to hold it tight in the valve disk, as shown in sketch at *A*.

Threads were put on the other end of the rod for a nut. Then the end with the threaded stem was screwed into the valve disk and the packing box put into place. A wooden plug with a hole in the center through which the rod could pass was made to fit the packing box.

The plug was hammered in place and a nut was screwed on the end of the rod

and a rope fastened to it. From a beam above, a tackle was fastened and connected to the rope on the rod. The engine was then started as usual and the valve was gradually opened by means of the tackle.

Some air leaked in around the rod where it passed through the plug. As this type of pump is given air on its suction, to make it run smoothly it is not necessary to stop the leakage. When convenient the pump was shut down and a new stem was put in place.

K. LAWRENCE.

Kansas City, Mo.

Tank Gage

Water is pumped from a well into a tank several hundred yards distant from the engine room. This tank is fitted with a float indicator, but owing to the fact that it was not in view of the engine room an inconvenience was experienced.

To remedy this fault a pipe line was run from the tank to the boiler room, on the end of which was connected a low-reading pressure gage. The gage was placed on the wall of the engine room beside the steam gage. Aside from having a very neat appearance, it is accurate and saves the attendant many useless steps.

H. ENT.

Conejos, Colo.

Boilers Foam

In my plant there are five 78-inch by 18-foot return-tubular boilers. These boilers are supplied with water from three sources: First, from what is known as table water from the mine; second, drain tile water from the farm, and third, deep-well water. The deep-well water is practically the same as the table water from the mine.

Trouble is encountered with the engines taking over water from the middle to the latter part of the week on account of the boilers foaming.

Nos. 1, 2 and 3 are domeless boilers and each has a 6-inch pipe connection about the center of the boiler on top for supplying steam to the main header. The water line is carried about 18 inches from the top of the shell.

No. 4 boiler has a 30-inch dome. Inside the dome, in the upper sheet, there are four 4-inch openings which allow steam to pass into the dome and through a 6-inch pipe to the main header.

No. 5 boiler has a 36-inch dome also and an opening of 8x14 inches in the upper shell inside the dome to allow the steam to pass into the dome and from there through a 6-inch pipe into the main header.

The foaming trouble only occurs when the hoist engines are in operation and, sometimes, after they have been in motion a few minutes. Most of the trouble apparently comes from the domeless boilers.

These boilers are washed out once a week and the water is carried as low as safety will allow.

Can any engineer suggest a remedy for this foaming and state whether the domeless boilers are responsible for the trouble?

JAMES M. STEWART.

Elgin, Ill.

Did Not Hook On

The diagram herewith is from the low-pressure cylinder of a Corliss cross-compound engine, one end of which did not hook on.

Why does the diagram from that end include any area? Why does not the expansion line follow back upon the same line as the compression?

Furthermore, the expansion line for the last half of its length runs practically parallel with the atmospheric. What holds it up?

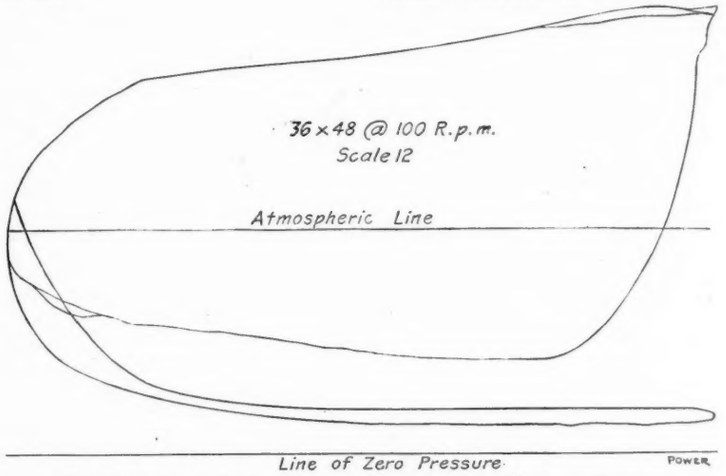


DIAGRAM FROM LOW-PRESSURE CYLINDER OF CORLISS ENGINE

The diagram was taken with a 12 spring.

Shall be interested to see the comments of POWER readers upon it.

S. E. MEAD.

New York City.

Co-operation

The personal factors in a power plant are, the proprietor or the board of directors, the chief engineer, the assistant engineers and the rank and file. Each of these has his own business to attend to and any encroachment causes friction and ultimate trouble.

The owner, or the board of directors in the person of the managing director, is the "boss." He superintends the marketing of the power and has plenty to do in interviewing and arranging terms with customers and keeping an eye on the net financial efficiency of the concern.

It is to the advantage of the chief engineer to get up schemes for increasing the efficiency and cutting the costs of the plant operation. To him should be left the purchase of fuel, lubricants and other supplies and stores, the examination of subordinates and the ordering of the internal management and working of the engine-room and boiler-house staff.

The assistant engineers should look upon their chief as a friend who is there to be consulted and not, as is too often the case, as a man who is holding down a better job and is, therefore, to be envied and, if possible, ousted. All repairs and adjustments should be made by, or under the immediate supervision of the assistant engineers and their reports should be passed on to the chief.

The rank and file, or the oilers, water tenders and firemen, should be under the immediate control of the shift engineer with whom they are working, but complaints of all kinds, whether from the ranks or from the assistants, should have the personal attention of the chief.

Everyone in the plant should have free access to the "boss" at all reasonable times. One of the surest ways to insure friendly coöperation and smooth working is by the "boss" considering the personal comforts of the staff by the provision of good accommodations in the way of coat cupboards, lavatories and the like.

JOHN S. LEESE.

Manchester, Eng.

Blowoff Valve Left Open

The boiler equipment of a plant where an accident recently happened, consisted of two return-tubular boilers set in one battery with the blowoff pipes connected to a single pipe at the rear.

One boiler had been cut out for cleaning, and, after it was washed out, the engineer went inside to examine the internal conditions. His assistant was left in charge of the plant. When the usual time arrived for blowing down the boiler under steam, he opened the blowoff cock.

The cock on the dead boiler was still open and as the steam filled the idle boiler the engineer inside was scalded to death instantly. This was the result of carelessness on the part of two men and both should have known better than

to have gone about their work with the blowoff valve open.

EDWARD T. BINNS.

Philadelphia, Penn.

Solvents in Boiler Water

In most methods of feeding solvents into steam boilers the amount of the solvent fed bears no fixed relation to the amount of the feed water used and, although the solvent may be fed in direct proportion to the feed water, the amount of the scale-forming matter in the water often varies. Therefore, some means of determining the strength of the solvent in the water in the boiler is desirable.

Too much solvent in the water is a waste and may also cause foaming; too little solvent leaves scale-forming matter that is not acted upon.

A simple test for compounds containing soda, soda-ash, or tri-sodium phosphate is phenolpthalein. If the phenolpthalein, which can be purchased at most any drug store, is dissolved in alcohol and five or six drops of the solution added to one-half pint of the water to be tested the water will assume a red or pink color, the shade depending on the amount of soda in the water. A large amount of the soda will produce a deep red color; a small amount will produce a lighter pink color.

If the sample of the water to be tested is drawn from the water column, care should be taken to blow out all condensation before taking the sample. The water should be allowed to cool before testing and the same proportions of solution and water should be adhered to for uniform results.

If the engineer will apply this test to the water in his boiler each day just before introducing the compound used and vary the amount of the compound according to the strength of that already in the boiler he will effect a saving in compound and secure better results.

G. E. MILES

Salida, Colo.

Skimmer Caused Boiler to Scale

There are two boilers in the plant where I am employed, one of 40 horsepower and one of 100 horsepower capacity.

Before a producer-gas plant was installed, the large boiler was used to run the works and the small boiler was used for heating purposes. Both boilers were fired extremely hard. The 100-horsepower boiler had a boiler cleaner attached to the back of the boiler on the inside for the purpose of removing all the scum from the water. The small boiler had no cleaner.

We cleaned the boilers once a month and used the same water in both and under the same treatment. To the surprise of all, the large boiler was always badly scaled and nothing that was done would prevent it. The small boiler never had as much as a double handful of scale, and that was in the form of a soft, white sludge that was easily washed out. The same boiler compound was used in both boilers.

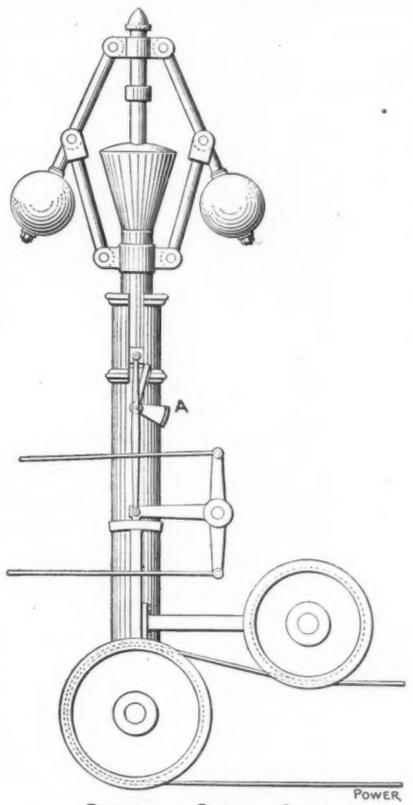
After weeks of hard work, I decided to take off the cleaner, and while some may think it a queer thing to do, it turned the trick. There has been no more trouble with scale and the tubes are as clean as the day they were put in. It appears that there was something in the water that the cleaner took out that prevented the boiler scaling when it got a chance to work.

H. WESTWOOD.

Waterloo, Can.

Governor Safety Stop

The accompanying sketch shows a safety device for a governor which I have had on a 16x42-inch Corliss engine that has been in constant service for 31 years. This engine carries a 16-foot



GOVERNOR SAFETY STOP

built-up type flywheel which weighs about 14 tons and has been in service 45 years.

Upon starting the engine one morning the governor failed to operate. After making a close examination I found that the key holding the pinion on the upright shaft had worked out. Had this key come out while the engine was running, the engine would have been wrecked. The governor is of the old style, with a safety device which acts only when the governor belt breaks, as shown in the sketch.

I afterward discarded the belt arrangement and fixed a safety latch on the governor column, as shown at *A*. This latch rests under the guide boss, which is connected to the bell crank, when the engine is not in motion. Upon starting the engine this latch drops out of the path of the guide movement as soon as the governor rises from it. This allows the governor full control, if either the belt should break or anything else should affect the gearing. The latch is held in place by the hand while the engine is being stopped.

R. L. BLACET.

Glasgow, Mo.

Burning Fuel Oil

The plant I am in charge of is burning crude oil as a fuel. The plant consists of a 55-horsepower automatic engine and a 16-foot by 54-inch tubular boiler. Before I started to burn oil I ran the plant on two tons of slack coal per day at $1.65 per ton.

Six barrels, 42 gallons each, of crude oil is now burned per day. The burners are of the jet type and air is drawn into the burner by the suction of the jet where it mixes with the oil in the burner.

The oil tank is located about 100 feet from the building and has a fall of 3½ feet to the burners. I would like the advice of other engineers as to whether I could run on less oil, and whether it would pay to install a pump and a gravity burner; would a heater be necessary, also?

W. A. HAMLIN.

Paola, Kan.

Automatic Lubricators

After an experience with automatic lubricators, since their introduction, I am convinced that their proper location is upon the cylinder or steam chest of the engine, for when so placed the temperature of the oil remains practically constant.

If the lubricator is located upon the engine frame, the temperature of the oil changes with that of the air in the room, and the amount of oil fed also varies. The ball valves used in the pump cannot seat quickly, because the low temperature of the oil causes it to become thick and the ball has a tendency to float in the oil; therefore, part of the oil drawn in at each stroke of the pump is forced back into the reservoir before the valves close. This causes the engineer as much trouble in obtaining a proper feed as the older style of lubricator.

The best results are obtainable when the plunger feeds two or three drops at each stroke and the speed of the pump is regulated to give the desired number of drops per minute.

ROY W. LYMAN.

Ware, Mass.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Engine Running Under

In the March 7 issue in reply to an inquiry it was stated that the frictional load on an engine is reduced by running an engine under instead of over. This decrease, it is claimed, is made by the diagonal thrust of the connecting rod pushing the crosshead against the upper guide with a pressure which is reduced by the weight of the crosshead.

I cannot see how the frictional load is reduced, as the connecting rod in order to lift the crosshead must put a pressure equal to the weight of the crosshead on the wristpin and crankpin, thereby reducing the friction in the guides but increasing it on the wristpin and crankpin.

RUSSELL B. BUCHANAN.

Leadville, Colo.

The Stuffing Box

The interesting "talks" on the stuffing box which appear serially in the advertising space of the current issues of POWER are worthy of consideration. The statements seem revolutionary, but I am heartily in accord with them.

One of these statements, that the square-bottomed stuffing box and gland are more efficient than the beveled sort, I have always believed. Any engineer may test this by fitting babbitt rings to the bevels. Then notice the difference in gland tension required to cause ordinary

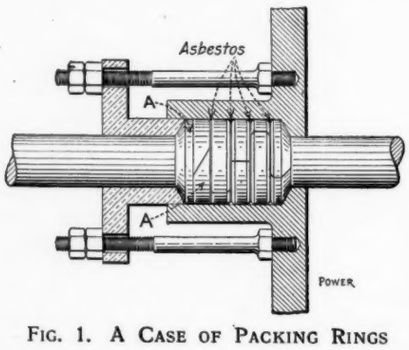


FIG. 1. A CASE OF PACKING RINGS

packing to become steam tight, as compared with that necessary to make the same packing steam tight, when the babbitt rings are omitted. As every turn of the gland nuts means increased friction on the rod, the experimenter will at once question the advantages of a beveled-bottom box. The life of the packing is considerably prolonged, as less of its elasticity is wasted when it is first applied.

Another valuable truth expressed by the writer of the "talks" is that, the temperature of the stuffing box being lowest nearest the gland, the inner rings of packing deteriorate faster than the outer rings. The inner rings, I believe, soon become nothing more than space fillers in the box, so that something more wearable and ultimately less expensive

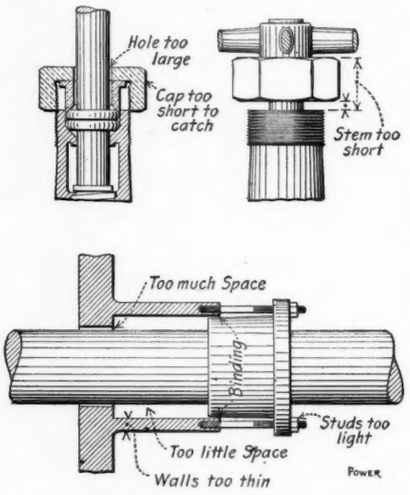


FIG. 2. COMMON FAULTS IN DESIGN

could be advantageously substituted. To test this, I once placed four well fitted babbitt rings of good grade in a certain stuffing box, which required six rings of ordinary packing to fill. Between each, a layer of asbestos was interposed, as shown in the sectional sketch in Fig. 1. Now this box when packed entirely with soft packing required renewal of its contents every six months, resulting in the use of twelve rings yearly. After the change was made the two soft rings *A* were found to give satisfactory service for four months, which now results in the use of only six rings yearly. Thus, at the expense of a little more labor, a material saving of packing was effected. And I believe there exists less total friction on the rod; though, probably, as all the friction is constrained within a narrower limit, there may be present a tendency to wear shoulders more quickly. As yet, however, the rod looks good, and shows no deleterious effect from the change, though the precaution of allowing more lubricating oil and distributing it better was taken.

I heartily wish that the writer of the

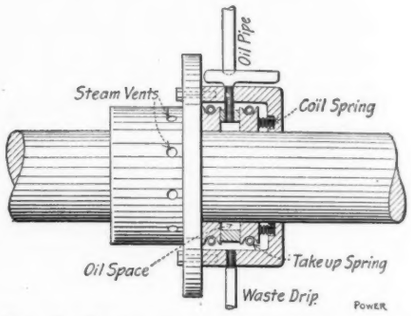


FIG. 3. PREVENTING SHOULDERS ON ROD

advertisement would discuss some of the evils of construction which at times sorely beset the engineer. In Fig. 2, I have endeavored to illustrate graphically the most common faults, with the expectation that they will be noticed by some designers. The stuffing box should not be cast integrally with the cylinder, but rather it should be bolted on in such a manner as to allow slight up and down adjustment, which would permit the packing to enter freely and fit snugly around a rod that is a trifle low of center. Even where adjustments can be made in the bull ring of the piston and the shoes of the crosshead, it is not always convenient to take off the cylinder head. If the rod is out of center with the stuffing box, how beneficial to the packing it would be, not only to be able to level the rod, but also to drop down the stuffing box to accommodate the new center, while waiting for an opportunity to center the piston.

I once ran across this improvement. An engineer had had his rod trued up and was fearful lest the packing would again form shoulders upon it. To prevent this, he bolted to the gland a small extension casing which inclosed two spring-tied metal rings; see Fig. 3. Between these he fitted a space ring which he ground oil tight with the two split rings, and into this space he led the oil pipe, which supplied a thin mixture of flour of graphite and cylinder oil. If he made a good job at surfacing the rings, it will be perceived that the rod is evenly lubricated.

M. CASSIDY.

South Framingham, Mass.

Dangerous Boilers

When reading Mr. Utz's letter in the March 28 issue, entitled "Operating a Dangerous Boiler," I was reminded of an old boiler at this place, operated by a railroad company. The boiler and engine are an old "traction" engine with the wheels removed. The back end of the boiler rests on two tee-irons and the front end is supported by railroad ties. A hole dug in the ground under the back end serves as an ashpit. The sheet around the rivets is wasted away to a dangerous extent and the plates are rusted and pitted badly. The boiler leaks badly around the mud ring and around the bolts that hold the bearing lug to the boiler. This lug supports the flywheel end of the crank shaft. The boiler is fitted with an old lever safety valve which is not in operating condition.

This outfit is used to drive a centrifugal pump which pumps water from a creek into a large reservoir. It is only run when the supply of water in the reservoir gets low. Anyone that can shovel coal is allowed to run it. One evening a few months ago, I happened along by the boiler house and saw the engineer (?) standing on the creek bridge about four rods from the boiler. I asked him what he was doing out there. He said that he was waiting for the steam to go down. When asked how much steam he had, he said that about two minutes ago when he left "her" there was 140 pounds.

WALTER B. BROWN.

Deshler, Ohio.

Water Hammer

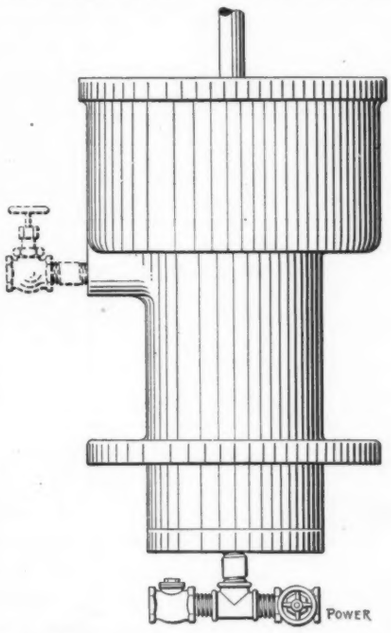
In reply to Mr. Payler's letter of March 7, in which he asks, "Is water hammer due to the presence of water lying along the bottom of the lowest part of a line of piping, or is it due to a conflict between the cold air and the inrushing hot steam which causes the violent hammering?" I think that water hammer is due to the above two causes; directly to the first cause, while the second cause helps it along, or indirectly due to it. When steam is admitted into a pipe containing air at a lower temperature than the steam, part of the steam is condensed. Water hammer can result if the amount of steam condensed is large enough to form a slug and if this slug travels at a rapid rate through the pipe. When steam is admitted into a line of piping containing cold air and water lying along the bottom of its lowest part, some of the potential energy of the steam is immediately changed into kinetic energy. This inrushing steam sets in motion the water that was there before and the condensed steam. It is the sudden stopping of this water by an elbow, a closed valve, etc., that causes the violent hammering. Again, the kinetic energy that the water had is now changed to potential energy, and if the pipe is not strong enough a rupture will occur.

THOMAS H. BROCKMAN.

New Orleans, La.

Dashpot Troubles

Dashpot troubles described by R. A. Cultra, in the April 18 issue, bring to mind something in that line which happened in a power station in which I was engaged some time ago. The low-pressure cylinders were equipped with the Corliss valve gear, with dashpots for the steam-admission valves. The pots had the regulation air-cushion valves attached, but in spite of these the pots would slam under heavy-load conditions. If attempts were made to adjust the air valves to stop the slamming, the pots would not act quickly enough with light or even normal loads. The adjustment could not be made so as to cover a reasonable fluctuation of load and so the engineers and oilers on watch were kept on the run (there were several engines to attend to), adjusting the air valves to maintain quietly dropping dashpots.



PROVISION FOR REGULATING AIR SUPPLY

The engines were vertical and so the dashpots were free and clear to be gotten at from any direction. Besides having the regular air valve referred to, the center of the bottom was drilled and tapped for an ordinary brass pet cock, to drain the pot in case of leakage of oil past the leather packing and also to admit air to the chamber when drawing out the pot for overhauling. These pet cocks were of little or no use as means of regulating the drop of the pots. It was a case of the pots either dropping too hard and slamming or not dropping fast or far enough.

Someone in the station suggested that the pet cock at the bottom be taken out and a check valve, opening outward, be put in. This was tried in one of the pots with partial success. With the check valve, the slamming was not quite as bad as before, but with very heavy loads the slam was enough to be troublesome. The next move was to have a globe regulating valve connected up with the check valve, as shown in the accompanying sketch. The quantity of air admitted could be controlled to a nicety and the best thing about it was, that it could be regulated to suit quite a range in load changes. On the upstroke of the dashpot a certain amount of air was admitted through the globe valve into the vacuum chamber; when the releasing gear permitted the pot to drop, the contained air was forced out of both the check valve and globe valve, bringing the pot to its seat quietly. This depended on the hight the pot had been raised and the amount of air admitted through the globe valve.

It did not require very much skill to regulate the globe-valve opening and, when regulated, it very seldom required any more than ordinary attention. All the engines were equipped in a similar way and the men were not bothered in that way again. It is the best plan that I have ever seen for the purpose.

CHARLES J. MASON.

Scranton, Penn.

High Pressure Drips

I noted R. E. Enigne's comment in the April 11 issue, on my criticism of Mr. Meinzer's arrangement for returning condensation from high-pressure traps to the heating main. I must say that I am still skeptical. Theoretically, there may be an apparent gain, but, practically, local conditions and the arrangement of the drip-return pipe have a great deal to do with the advisability of so utilizing the drip returns.

I have a number of high-pressure traps in the place where I am employed and I find that the drip-return pipes are quite cold, a short distance from the trap. This would indicate that the heat liberated through a drop in the pressure will recondense very quickly if led away in the same pipe with the condensation. As a matter of fact, I am inclined to believe that evaporation and recondensation take place almost simultaneously.

I have had experience, as marine engineer, with compound to quadruple-expansion engines, but I have never run across such an arrangement as Mr. Enigne describes, although I readily see the advantage that may be gained by something like it but not exactly the way Mr. Enigne describes the arrangement; that is, to drain the high-pressure condensation into the low-pressure receiver. If the outlet of the high-pres-

sure traps are connected to the low-pressure receiver by a vapor pipe which carries the vapor only to the receiver, instead of the whole condensation, the results undoubtedly would be beneficial, but if the whole condensation is led into the receiver, I am very skeptical of results.

The same thing in my opinion is true when returning high-pressure drips to the heating system. If the traps should be lined up along the heating main and piped at the outlet with a vapor pipe to the heating main and a condensed-water pipe to the heating return, I have not the slightest doubt of the benefit to be derived.

Condensed water when released from under, say, 100 pounds to atmospheric pressure or slightly above, as used for heating, will liberate enough heat to evaporate approximately one-tenth of the water. If this liberated steam is collected from all over a large plant in a common return with the condensation and carried any distance, I am of the opinion that it will recondense before getting into the heating main.

At any rate, I would not recommend to anyone to invest good money in an improvement, which seems to me very doubtful of beneficial results.

VICTOR BONN.

New York City.

Water Coils Burn Out

Many good men have encountered the difficulties described by R. A. Booth, in the April 4 number. Coils placed in a furnace require a continuous stream of water circulating through them to prevent pipes from bending or burning out. The scheme of running feed water through pipes placed in the combustion chamber has been attempted with unsatisfactory results.

An exhaust-steam feed-water heater is probably the most economical method of heating feed water; otherwise the exhaust is wasted. Exhaust from all steam pumps and other engines should be utilized for this service with proper heaters. Live-steam feed-water heaters always proved to be a success where they were properly installed and equipped. Peculiar as it appears, it has been proved that a decided economical advantage is gained with live-steam feed-water heating over hot-water heaters separately fired. Where I am employed, there were three boilers directly fired for heating-water purposes only; they were cut out and a large live-steam feed-water heater was installed. The heater received its steam supply from a battery of steam boilers already in use.

I hesitate to state the amount of fuel saved for fear my veracity may be questioned. I will state, however, that the saving in labor and fuel was considerable and that the water supply was even more satisfactory than in former times.

The pipe described by Mr. Booth burned out or bent because the water heated up to such a degree that an overpressure was raised, forcing the water out of the pipes into the boiler and leaving the pipes empty for a short period. While empty the pipes were overheated and ultimately burned out. If they lasted four months with Mr. Booth they did exceptionally well.

In several cases serious accidents have happened to boiler brickwork, due to ruptures of the feed pipes in the furnace space.

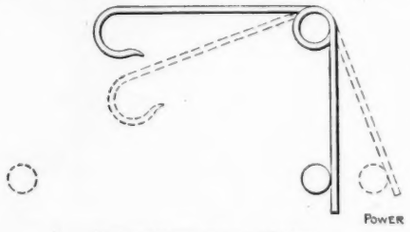
J. E. NOBLE.

Toronto, Can.

Indicator Cord Hooks

I noticed in the March 28 issue of POWER an article on indicator-cord hooks by Julian C. Smallwood. I am using a hook which is similar to the one Mr. Smallwood describes, only I believe my hook has his beaten for high speeds. After numerous attempts with several different kinds of hooks, I gave up the task of trying to indicate a high-speed engine, which was part of the power equipment of my plant.

While searching the advertising sections of POWER for a way out, I ran across a small cut of a Trill indicator with a cord hook attached. I sent for



INDICATOR-CORD HOOK

the hook at once and tried it out. I was both pleased and surprised at the results. The engine ran 220 revolutions per minute, and I indicated it without an error on the part of hooking on and unhooking. The illustration shows the hook and the method of attaching.

To hook on, hold the eye of the hook lightly between the thumb and forefinger and above the rod onto which you wish to hook. Advance the hand forward so that the hook will overlap the travel of the rod about 1½ inches. When ready to hook, drop the hand suddenly so that the rod may strike the lower part of the hook.

To unhook, close the hand around the cord and advance toward the hook until at its extreme travel it nearly touches the hand. When ready to unhook, suddenly advance the hand forward about 1½ inches, allowing the forefinger to strike the lower part of the hook.

JOHN C. PITTS.

Cherokee, Okla.

Cleanliness in the Power Plant

The editorial in a recent issue on the above subject was interesting and correct. There is perhaps no one who does not admire beautifully polished and well groomed machinery and clean, orderly power plants. It pays to keep them in that condition.

A corner filled with filth and trash invariably invites and receives more of the same. Rusty and oil-stained brightwork means more and continued rust and stain, and a greasy and ill kept floor will get into such a chronic state of deterioration that everyone who comes along will take pleasure in adding to the general mess.

Such conditions mean a slovenly crew who are too lacking in pride and ambition to keep up and properly care for the requirement in their charge, too indolent to be concerned or interested in anything but the clock.

Where the spirit of cleanliness and order is lacking in the chief, it is apt to be absent among the crew and the tendency is toward the plant "running down." In time this means a general overhauling more costly by far than if the care had been given in the regular daily order of things.

It is very easy to keep a plant to the top notch of cleanliness when once started in that direction. The spirit of neatness is infused into all hands and becomes a habit. An employee, though not directly interested, would look twice before dropping a piece of waste or trash upon a freshly scrubbed floor, and he would be a great deal less apt to roughly handle or mar the clean and shining valve gear than the rusty and oil-stained one.

Cleanliness about the power plant fosters thoroughness and carefulness in the employee, and often leads to the detection of flaws in machinery that might go unnoticed were polishing and wiping not attended to. It raises his self-respect and develops his esthetic qualities.

Cleanliness always pays from the standpoint of the engineer. Traveling salesmen spread the fame of a power plant, mill or factory of exceptional cleanliness, and the name of the engineer responsible for it becomes favorably known over a wide territory. Better positions have frequently been obtained in this way.

A young man holding his first position as chief in a small power plant was approached one night by a visitor who had been admiring the spick and span condition of the little station and was asked if he could keep a certain factory as clean as he did that station. He gave an affirmative answer and forgot the incident, but two years later he was sent for by his erstwhile visitor and made superintendent of the factory mentioned.

His cleanliness and good order were his silent though eloquent recommendations.

In another case a firm had been much embarrassed by the insurance inspector's reduction of ten pounds of steam from the boiler pressure. A new engineer cleaned the room and settings thoroughly, scraped the boilers inside and out and the insurance company voluntarily raised the pressure to its former limit.

For a similar reason a fire-insurance inspector will frequently recommend a reduction of rates on an otherwise bad risk because of the good order and cleanliness or "on account of management."

Yazoo City, Miss. F. C. HOLLY.

Piston Rings

I noticed in the April 11 issue of POWER, George H. Handley's favorable comment on a letter, contributed by me in the March 7 issue, on the lap-joint and diagonally cut piston rings. It seems that his plan for leakage prevention in rings of the lap-joint order is not exactly faultless, though an improvement when used in conjunction with this ring.

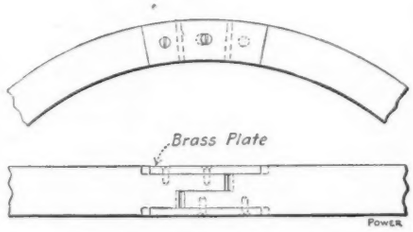


FIG. 1. MR. HANDLEY'S METHOD

There are two objections to the use of such a ring as Mr. Handley proposes: First, he says that care must be taken to use tap screws of proper proportion, with thin rings—an acknowledgment that the ring is unduly weakened at an already delicate point. This has been proved by numerous reports of instances where "tips" of rings of this order have broken and caused a badly cut cylinder, if not a general smash up, even though they were made as strong as possible.

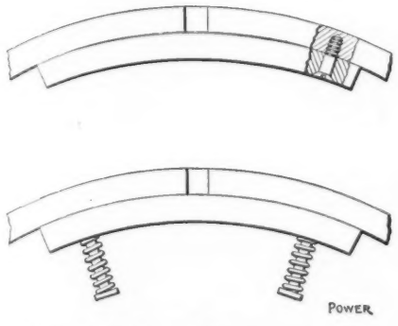


FIG. 2. BACKING UP PISTON RING

In the second place, this does not render the ring absolutely "leak proof," since leakage will occur past the brass plate when the ring becomes worn. This leakage, however, cannot be so great as in the ring without the plate, because the opening exposed is not so great and, too, the steam has a more constricted and "round about" passage to cross over, before reaching the other side.

I believe the method I proposed is less objectionable, because the ring cannot leak, if the cover plate is properly made. The ring would not be weakened much, even if a small hole were drilled and a curved-spring cover fastened underneath, as indicated in the cut. Whereas, in Mr. Handley's plan, the ring is much weakened by drilling across the ring and more still by the cut on each side.

LLOYD V. BEETS.

Nashville, Tenn.

Central Station vs. Isolated Plant

This is in confirmation of W. J. Creelman's article under the above heading in the April 18 issue. It should be remembered, however, that the conditions at each place must be fully considered before judgment can be passed. After an ordinance had been passed, forbidding the installation or retention of boiler rooms under sidewalks, the question among business men arose as to whether the purchase of light and power, as formerly done, would be cheaper than the running of a private plant. The city and central plant referred to are among the largest in the country.

To purchase the power would cost about $67,000 annually, which was quite an item. The engineer convinced the owners that it would be cheaper to install their own plant, and here are a few of the obstacles they overcame in doing so:

It was a case of swapping places with the kitchen as a starter. Then this change of location necessitated a new chimney, and to accomplish this meant the sacrifice of a living room on each floor, clear to the top of the hotel. The complete change cost $100,000.

When they came to excavating about the boiler room, it was noticed that a great amount of seepage was present, and kept increasing as excavations progressed. Many of the older buildings in our city are on what are called "floating foundations," and at places where our building had settled, the plumbing drains beneath the cellar floor had broken at various places, causing the seepage. This required the complete overhauling of all the plumbing drains, which amounted to an additional $50,000. Since completing the plant they have been enabled to save from $30,000 to $37,000 annually over what it would have cost them had power been purchased at the above price.

C. S. COLLINS.

Notre Dame, Ind.

I have read so many arguments for and against the isolated plant that I would like to put in one word myself. I positively know that the isolated plant will pay if properly installed and given a fair chance. Too many plants are thrown together with cheap apparatus and little discrimination.

One of the first things which should be looked after is to see that good apparatus is provided and carefully installed. If the engineer on the job cannot do it, put the work in the hands of some good conscientious consulting engineer. Then by all means have a system of operation. Keep track of every detail. Run it as any successful business is run—as the central station is run. When asked for reports have them on tap. Then you need not fear the outside interests. Reports are as important as the operation of the plant. We have been running here for seven years and have not had a shutdown for any cause, except when cutting into lines to add apparatus—this is done after midnight. We run day and night the year around and have produced electrical energy for 1.06 cents per kilowatt-hour. While the central station is all right in its place and is needed, it cannot touch the isolated plant if handled right. The report shows what we are able to do. The output was considerably increased without adding to the running expenses.

COMPARATIVE COAL AND LOAD DATA

Dates	Coal	Load, Kw.-hours	Elevator Trips	
1907				
Oct.	221,269	23,890	21,947	Used 25,246 lb. more coal 1909 than in 1908, and generated 13,350 kw.-hours more current.
Nov.	223,371	21,010	21,127	
Dec.	225,669	25,530	21,641	
Totals.	670,309	70,430	64,715	
1908				
Oct.	210,185	29,150	22,045	Increase in fuel used 1909 over 1908, 3½%. Increase in kw.-output, 14%.
Nov.	214,731	30,000	19,997	
Dec.	222,980	33,090	21,193	
Totals.	647,896	92,240	63,235	
1909				
Oct.	212,018	33,910	21,385	Increase in fuel used 1909 over 1907, 4½%. Increase in kw.-output, 33%.
Nov.	222,094	34,910	21,139	
Dec.	239,033	36,770	22,614	
Totals.	673,145	105,590	65,138	

ASA P. HYDE.

Binghamton, N. Y.

Dennie Flanagan, th' ingineer et th' light plant, hez a dago firin' fer 'im. Dennie got a box uv rubber tubin' fer makin' gaskets fer th' manhole plates in his bilers an' when he went t' use sum uv it he diskivered thet th' dumd dago hed et it up, thinkin' thet it wuz sum new kind uv macaroni.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Causes of Pitting of Boiler Tubes

The tubes in my boiler are pitting badly. The feed water comes from a coal mine most of the time, but I use rain water when I can get it. What causes the pitting?

M. F. H.

The pitting is caused by sulphuric acid in the water which comes from the mine. The acid may be neutralized by an alkali. Equal parts of unslaked lime and crude soda ash dissolved and fed to the boiler with the feed water will stop the pitting. But just how much to use can only be determined by experiment. Blue litmus paper will turn red in the water if acid is present and the red paper will turn blue if there is an excess of alkali. No change of color will take place if the water is right. If the water is passed through an open heater, most of the solids will be deposited there.

The soda will serve to prevent some of the scale-forming material from depositing as a scale and will keep it in a condition in which it may be blown out. An analysis of the water will determine whether soda or something else is better for this part of the process. Heating the water to 200 degrees or over will cause most of the scale-making impurities to precipitate.

Advantages of Butt-Strap Boiler Joints

Why is a butt- and double-strap boiler seam a better form of construction than a lap seam?

L. J. F.

The butt joint allows the shell to be built truly cylindrical while the lap joint prevents it. The pressure inside the shell tends to make it round and this tendency bends the lap-jointed sheet near the outer row of rivets at every change of pressure, however slight. As the pressure changes at every stroke of the engine, there are thousands of bending effects each hour. With the butt joint if the shell is round at the start changes of pressure do not bend the sheet.

Capacity of Expansion Tank

What capacity of expansion tank will be required for a hot-water system of 30,000 square feet of radiating surface, allowing 1.75 pints of water per square foot, assuming that the water expands 0.00043 of its volume for each degree of rise in temperature?

J. J. B.

It will require $1.75 \times 30{,}000 = 52{,}500$ pints of water. Assuming a temperature rise in the water from 60 degrees to 200 degrees, the increase in volume of the water will be $0.00043 \times 140 \times 52{,}500 = 3160$ pints, or 395 gallons, and the expansion tank should have this capacity. This is a little over 5 per cent. of the capacity of the system. Heating engineers usually allow 10 per cent. of the volume of the system for expansion with a temperature rise of 120 degrees.

Safety Valve Blow Back Adjustment

If a safety valve is set to blow at 100 pounds and stops at 90 pounds, how can it be adjusted to stop at 98 pounds?

C. D. N.

In most pop safety valves there is a supplementary ring surrounding the valve disk which forms a huddling chamber, increasing the effective area of the disk. This ring is threaded and may be turned, through the holes provided in the case, increasing or diminishing the huddling area. Increasing this causes more blow back, and diminishing it causes less.

Flat Bearing Surface

Can a perfectly flat surface, suitable for a bearing, be made on a planer? If not, how can it be made?

P F. S.

A perfectly flat surface cannot be made by planing. Such surfaces are obtained only by scraping. For some kinds of bearings planed surfaces are suitable but not if extreme accuracy is necessary.

Producer Output

How much horsepower should a No. 7 Wood producer deliver, using Texas lignite?

How many cubic feet of gas should be delivered per pound of lignite gasified?

With gas of 135 B.t.u. per cubic foot, how many horsepower should a 600-horsepower gas engine deliver at the belt?

H. W. N.

A producer does not deliver horsepower, but the horsepower that can be developed from producer gas depends on the quantity and quality of the gas and the efficiency of the engine. With lignite of 8000 B.t.u. per pound a No. 7 producer will deliver about 25,000 cubic feet of gas an hour containing about 125 B.t.u. per cubic foot; a good engine will develop about 300 brake horsepower on that quantity and quality of gas.

From 35 to 55, according to the character of the lignite and the way the producer is handled.

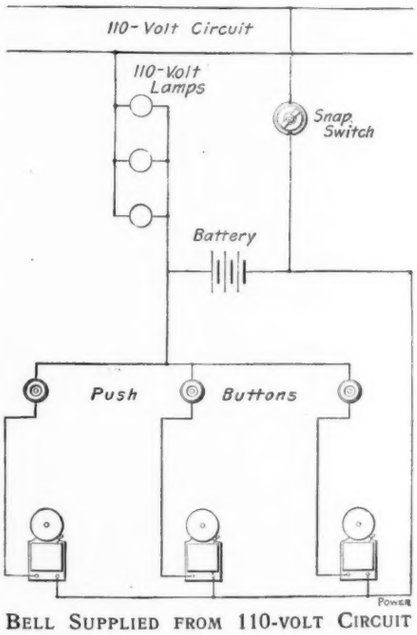
Its full rating: 600 horsepower.

Reducing Direct Current Voltage for Bells

How can I make a transformer to reduce the voltage of a 110-volt direct-current circuit to about 5 volts for ringing bells?

E. G. H.

You cannot. A transformer will not work on direct current. If you have a large number of bells, the best arrangement is a dynamotor to take motor current at 110 volts at one commutator and



BELL SUPPLIED FROM 110-VOLT CIRCUIT

deliver bell current at 5½ volts at the other. If you have only one or two bells, connect three or four 110-volt incandescent lamps in parallel with each other and in series with three storage-battery cells; then supply the bell circuit from the terminals of the battery, as indicated in the diagram.

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POWER

A Square Deal and Efficiency

The manager was recounting the advantages that had accrued on the installation of a series of devices that enabled him to keep accurate record of operating conditions. The changes had brought the plant from chaos, on the one hand, to system, order and economy on the other; from guesswork and hit-and-miss methods, worry, loss and inefficiency to smooth running and profit making.

But after all this, he wound up with the information that, "For a short time we gave the firemen a small bonus for good performance, to find out what they could do. After they had demonstrated what they could do if they tried, we set their best mark as a standard and made them live up to it!" That is one way of doing business.

Every manager must determine at the beginning whether he will or will not give his men a square deal. On this depends in a great measure the permanent success of the undertaking. Dissatisfaction among the men may easily result in as much loss as a lack of proper cost keeping. Bonus systems, in one form or another, have been introduced in many places, with good results, but if a firm does not intend to keep up the bonus system when once installed, it had better not establish one at all, for the reaction when it is discontinued is bound to result in dissatisfaction.

It would be interesting and rather instructive, we imagine, to look over the payroll of this company about the time the bonus was discontinued, and note the new names looming up on the list.

Habitually getting new names on the boiler-room payroll is not a policy which can be followed to the best advantage. The new man, however willing, will require time to attain the efficiency demanded and this will mean loss of money to the company. One firm estimates that it costs one hundred and fifty dollars, in inefficiently burned coal, to break in a new fireman. At this rate it will not require many changes in a year to mount up to a respectable figure. One day and one night fireman changing every two months would mean, on this basis, a loss of eighteen hundred dollars a year.

The better way is to keep the men who have been trained to the standard of efficiency prevailing in the plant, giving them substantial evidence of appreciation, and this, in connection with an accurate system of cost records, will go farther toward insuring a high and continuous state of efficiency than any other plan that can be adopted.

Legislation and Engine Accidents

Many of the States have factory-inspection boards, whose duty it is to inspect factories and to call attention to conditions inimical to health and safety. The duties of these inspectors are often laid out with a precision which leaves them little, if any, discretion, and in most cases, beyond calling attention to actual violation of the law, they have no power to enforce their recommendations.

A matter which naturally receives general attention is the placing of guards about moving machinery, the prohibiting of projecting set screws upon revolving shafts, etc. One of the provisions directed at the reduction of injury from accidental entanglement with shafting, or from a machine gone wrong, is the requirement of a clutch upon each floor, by means of which the motive power may be cut off in case of accident. While this may occasionally serve its purpose, although the damage has usually been done before the clutch can be thrown, it has in it the possibility of aggravating trouble and precipitating a catastrophe which might otherwise be averted. If the engine commences to race and the machines to run wild, the natural impulse of somebody on every floor will be to throw the clutch, taking the load off from the engine and aiding it in its race to destruction. The fragments of a big flywheel ploughing their way through the several floors may be the result.

A much more logical and a safer arrangement is a number of reliable circuit closers or other arrangements conveniently distributed throughout the building, by the use of which the engine may be shut down in case of accident. The mechanism by which this is effected may be, and usually is, arranged to be operated automatically by a device attached to the engine itself and independent of the governor in case the speed increases beyond a fixed limit.

In some of the States automatic engine stops are required by law, but the law is not always sufficiently explicit to require an engine stop in the true sense. It might be maintained, for instance, that

the usual safety cams on a Corliss engine constitute an "automatic engine stop," preventing as they do the hooking on of the valves and the admission of steam when the governor balls fall below a certain plane. But this is really a part of, an attachment to, the primary governor and subject to derangement with that governor. If the governor belt breaks and the balls drop, it will act; but if the belt slips, so that the governor runs slowly enough to permit a late cut-off, but not so slowly as to bring the safety cams into play, there may be an accident. It is a too common practice, moreover, to leave in place, while the engine is running, the pin which holds the safety cams out of action while starting up, although most modern engines are fitted with latches which automatically drop out of the way when the governor collar rises away from them.

A rider upon the governor belt, arranged in any of the usual ways to shut off the steam when the belt breaks and the rider falls, might be construed as satisfying the requirements of the law; but it is far from a positive safeguard.

The law should require specifically, and every provident engine owner should install whether the law requires it or not, a device entirely independent of the main governor, which will positively cut off the supply of steam when the speed becomes excessive. The danger in a mass of swiftly rotating metal is very real, and destructive explosions of flywheels not uncommon. There were twelve reported in January, and four each in February and March of the present year. Such an explosion may be far-reaching in its effects. The fragments of a wheel fly for hundreds of feet and are ugly and destructive missiles. People who live and pass near industrial establishments, as well as people who are obliged to pass their working hours within the range of flywheels, should have the assurance that something more than a two-inch belt and a fallible ball governor stands between them and eternity.

The Laborer Is Worthy of His Hire

The manager of a small hotel where an isolated plant has been in operation for some time says that if he had it to do over again he would install central-station current and go back to his old low-pressure heating system.

The plant in question is a model little installation which is saving the company twenty-five or thirty dollars a day net, and paying about twenty-five per cent. on the investment. It is not owing to financial considerations that this manager is so much dissatisfied. He claims that it is impossible to get competent help to operate his plant and that the petty labor troubles to which he is subjected are causing him more gray hairs than the money saved will warrant.

He is always worrying for fear the night engineer will get careless and explode the boiler, causing heavy damage suits as well as property loss. All manner of imaginary calamities haunt his mind and he claims to have a constant load of anxiety which he would be glad to pay twenty-five dollars a day to get rid of. This is one of the strong arguments of the central station. It seems to work out to perfection in this case.

As a matter of fact, he is trying to run his plant with the same wages and class of help that he formerly paid for janitor service with his old low-pressure heating system. It cannot be done. An electrical plant delivering twenty-four-hour service must have supervision of a higher order.

If this manager would take two dollars and a half a day out of his savings of twenty-five dollars a day and add it to the wages of his day and night engineers, dividing it in proportion to the money they are now receiving, he could get men who would operate his plant in a first-class manner and there would be no necessity for him to lie awake nights waiting for something to happen.

And, incidentally, he cannot get rid of that worry by putting in central-station current, for he will have to have boilers in operation all the time for hot-water service, and a "low-pressure" boiler can raise as much fuss as another when its pressure accidentally becomes "high."

Technical Graduates and the Public Service

A recrudescence of the disposition of examining boards to look rather to where a man got his knowledge than to what he actually knows appears in an advertisement by the Municipal Civil Service Commission in a New York daily announcing an examination for the position of mechanical engineer in the office of the Commissioner of Public Works.

Candidates must be graduates of a technical school and have had drafting room experience on details of mechanical appliances, together with at least three years' experience in assembling and erection of units connected with steam plants. They must show a familiarity with the details of complete mechanical equipments of public buildings—plumbing, elevators, heating, electric lighting, pumping and power systems.

We submit again that it should be no concern of a civil-service commission or other examining board whether a candidate got the knowledge requisite for the position at an institute of technology or at home on the kitchen table *so long as he has got it*. It is for them to know the kinds and degrees of knowledge which he should possess and to determine by examination whether or not he possesses them; and if he does possess them and can prove it, he ought to be as eligible to the position as another of equal attainments, whether he has gained a degree in the classic shades of a university or won competence in the school of experience.

Duplication in the Power Plant

To insure continuity in the operation of steam plant it is necessary to install considerably more apparatus than is actually necessary.

Naturally, the character of the load carried by the plant has much to do with the character and arrangement of its machines. A manufacturing plant generally contains just enough power units to operate the works. No idle engines are seen, the boilers are all under steam and there is just enough auxiliary apparatus to keep the plant in operation with everything working satisfactorily. If, due to an accident, such a plant is shut down, it affects comparatively but a few people.

But, if the plant were used for electric-lighting or street-railway service, a more exacting service would be required. In this case the public is to be served and a shutdown becomes a serious matter.

Many of these plants were formerly fitted with duplicate units throughout, duplicate feed-water and steam lines and apparently every precaution taken to guard against a possible shutdown. This practice, although expensive, has been the means of preventing a tie-up of the service, and accidents to the machinery have been tided over by the duplicate units without a break in the service.

Probably the weakest part of a modern power plant is its piping system. Exposed to varying degrees of temperature in the steam main, the action of acids and other deteriorating elements in the feed-water mains, together with water hammer and strains due to other causes, the pipe lines of a power plant should claim the particular consideration of the designing engineer.

Formerly it was considered good practice in the larger plants to install duplicate piping connections to the main units. Due to the large initial expense, increased radiating surface, double the number of joints and valves to keep in repair, the present-day engineer has reverted to the single pipe line, both for boiler feeding and for supplying steam to the engines.

To insure continuity of service, such a system requires good material, careful designing and placing of valves so that a break at any point in the header will not interfere with the operation of a single unit, for, if proper provisions are made, steam may be obtained on either side of the break. Although the single pipe line has its disadvantages, it is now considered preferable to the older method of duplicate piping.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

Union Clam Shell Buckets

The Union clam-shell bucket is designed for handling hard and soft coal, sand, gravel, crushed stone and earth excavations.

The bucket is designed so that the closing drum does not sink into the substance being dug, but revolves in fixed bearings.

The advantages of this type of bucket are as follows: First, the weight of the drum adds to its momentum when falling, and exerts a downward force. Second, the drum cannot sink into the material being handled, thus insuring a full load, and third, the bucket does not spill its contents when in transit, due to the shields over the top of each section.

The design of the bucket shown in Figs. 1 and 2 is known as class A and is rigged with a fixed frame and flexible head. This is used mostly for handling coal and loose material. It has an unusually large reach, is light and takes up very little head room.

Class B has movable supporting arms and the bowls are manipulated by a link motion, and is designed for handling crushed stone, sand, coal and light excavation.

Class C is built on the same principle as class B but is heavier in construction. This style of bucket is used for heavy work. Teeth are furnished with this bucket when desired.

The drum is made of a steel casting of the self-oiling type and holds approximately one quart of oil. The bowls are made of flanged steel with flanged corners only. The arms are of iron and are built to withstand heavy strain. The shoes are made so that they may be easily removed and are of steel.

These clam-shell buckets are made by the Union Iron Works, Newark avenue, Hoboken, N. J.

Governor Valve Oil Relay

An oil-relay system, for large high-pressure turbines, has been developed for operating the primary and secondary admission valves of the largest size of Westinghouse high-pressure turbines.

The operation of this relay will be understood by referring to the accompanying illustration, in which sections through the operating cylinder *A* and valve *B* are shown. Attached to the operating cylinder is a safety release valve *C* that is under the control of the speed-limit device.

The governor operates the rock shaft *D*, and its motion is transmitted to the pilot valve *B* through the arm *E*, link *F* and the floating lever *G*. According to whether the governor weights move in or out with increase or decrease in load, the pilot valve will either be raised or forced downward from its neutral position, admitting the oil (under pressure from the chamber *H*) underneath or above the relay piston, as the case may be, at the same time opening the ports at the opposite end of the cylinder to exhaust through the passages *I*. The oil-pressure chamber is located between the exhaust passages so that leakage escaping from the relay pistons is prevented. A drain pipe is provided to entrap the small leakage past the relay-piston rod.

As soon as the operating piston has traveled a short distance, it returns the pilot valve to its closed position, by means of the floating leyer *G*, immediately restoring equilibrium, and thus holding the admission valve in a fixed position. The floating lever *G* first turns about the joint *K* as the position of the governor clutch which imparts the governor travel to the rock shaft *D*, changes, and then swings

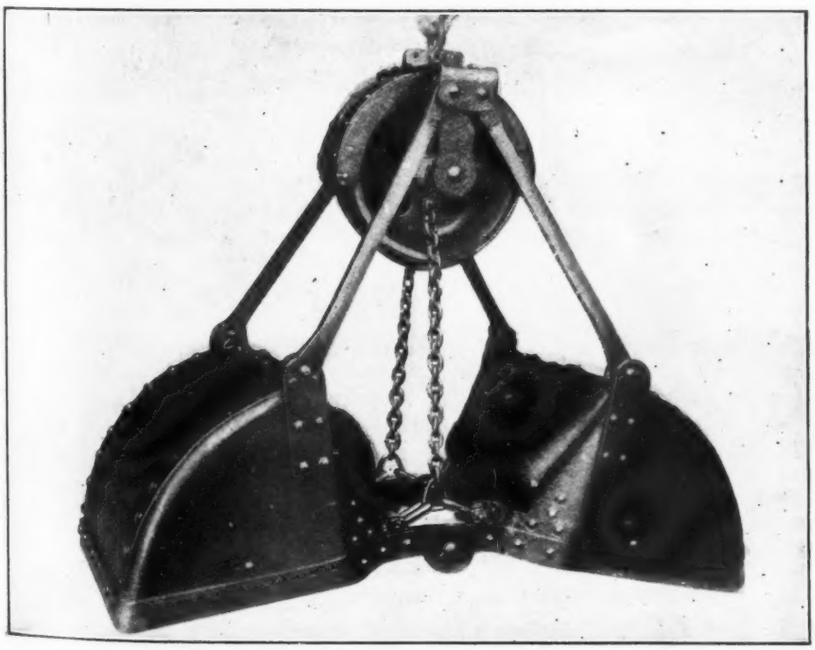


FIG. 1. BUCKET OPEN

FIG. 2. BUCKET CLOSED

about *J* as the relay piston *A* begins to move. As soon as the governor gives the pilot valve *B* one direction of travel, the following motion of the operating piston will immediately reverse it, closing both ports and locking the valves in a fixed position until further movement of the governor takes place.

The motion of the relay piston *A* is transmitted to the primary valve *O* and the secondary valve *P* through the levers *M* and *N*. The arrangement of the two levers for the two valves will be found the same, with the exception that the secondary-valve linkage is provided with an adjustable backlash at *R* so that the time of opening of the secondary valve may be changed by the operator. Ordinarily, this valve is regulated to open at the moment the primary valve *P* has reached its maximum port opening. To overcome the friction of rest provision is made for the fixed oscillation of the plunger, which causes a very slight up and down motion of the main operating piston, and the main poppet valve. This, however, is not sufficient to cause any observable fluctuation in the flow of steam to the turbine. The advantage of this method is that the governor becomes more sensitive, and the least move of the governor produces its consequent change of steam distribution.

The oil-relay apparatus will use more oil than the steam-relay system, but this oil is afterward used in the bearings. The oil required for this apparatus involves nothing additional in the turbine system beyond the oil-relay mechanism. The same pump is, as heretofore, pumping the oil at a somewhat greater pressure, and delivering a constant supply to the relay system. A spring-loaded by-pass valve is provided in the pipe line so that the oil in excess of that required by the relay escapes through this valve. This surplus oil together with the exhaust from the relay is led to a cooler and thence to the bearings as usual, whence it is again returned to the reservoir and back to the pump.

The poppet valve possesses some novel features.

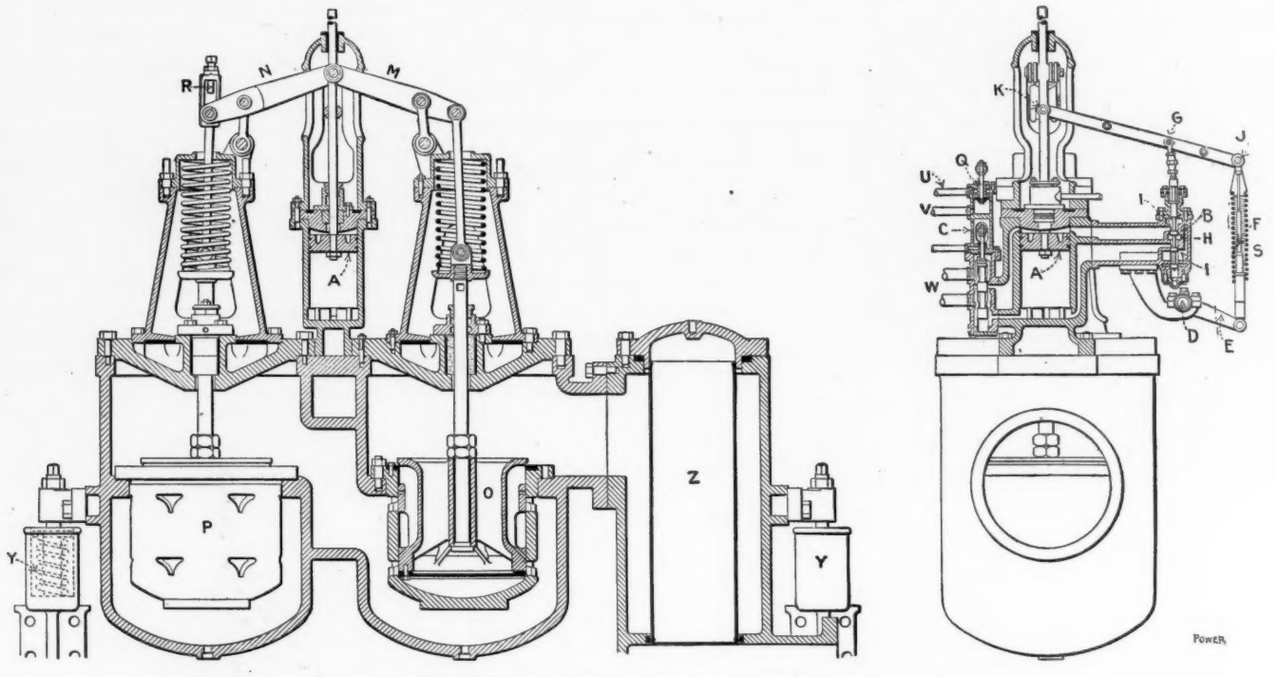
The valve is essentially a combination of a poppet valve and piston valve, the poppet-valve feature being in effect only when the valve is closed, or nearly so. When the valve is partially closed, the opening past the valve seats is at all times very much greater than the passage through the ports. Hence wire drawing of the steam will take place at the latter point, where it can do no harm. The valve ports are all of a peculiar form, so as to admit constant increments of steam for constant increments of valve lift.

In addition to the automatic throttle, an auxiliary safety steam valve *Q* is provided, receiving live steam at *U*. With leakage of steam past the piston, it is held in a raised position due to the unbalanced pressure. When the automatic trip operates, the steam from underneath this piston is exhausted through the outlet *V*. Through external linkage, an oil valve *W* is then operated which relieves the pressure above the relay piston and admits the pressure beneath, correspondingly forcing it to the top of the cylinder, thereby closing the valve.

In order to relieve the turbine casing of any strains due to the operation of the oil-relay system, the steam chest is mounted on the bedplate and supported by heavy coil springs, as shown at *Y* and *Y*.

Steam is supplied to the valves through the strainer *Z* and the secondary receives its supply through the primary valve. The governor link *F* is provided with a compression spring *S*. On shutting down the machine, relieving the oil pressure, the effort of the governor weights to come together would tend to raise the primary valve, which tendency would be resisted by the main spring on the primary valve. This would put a serious strain on the governor linkage, but the interposition of the comparatively light spring *S* in the linkage absorbs the governor travel without imposing any undue strain on the regulating mechanism.

Should the oil supply to the relay fail, the main spring would bring the valves to their seats, raising the relay piston to the highest position. The governor would then have a tendency to open the valves through the lever *G*. But as the spring *S* is unable to operate against the more powerful main-valve springs, it collapses and prevents the lifting of the main valve by the governor.



SECTIONAL VIEWS OF THE GOVERNOR-VALVE OIL RELAY

This oil relay is manufactured by the Westinghouse Machine Company, East Pittsburg, Penn.

Pete Blowoff kum inter my ingin room tother day an' sed thet th' exhoust uv my ingin sounded jist like th' pants uv a fat pug dorg thet hed bin tryin' ter ketch wun uv them Kansas jack rabbits. It sorter riled me an' I landed on 'im with wun uv my number tens jist ez he wuz gettin' out uv th' door. Pete sez thet he's bin havin' trouble with his main bearin' ever sence.

Meeting of the American Association of Refrigeration

The second annual meeting of the American Association of Refrigeration was held in the east assembly room of the La Salle hotel, Chicago, May 9 and 10, Theodore O. Vilter, president, presiding. In opening the meeting the president gave an account of the visit of the American delegates to the second international congress of refrigeration, at Vienna, and urged upon members of the American association the importance of making the coming international congress in this country in 1913 a success. After the report of the secretary and treasurer the meeting adjourned in a body to the blue room of the La Salle hotel, where a luncheon was served to all those in attendance, as guests of the association.

The following session was occupied largely with the reports of standing committees and with the consideration of cold-storage subjects. Another subject which engaged considerable attention was that of the adverse legislation which is being introduced in many States. Special committee reports were made on this subject and means for obtaining proper consideration of cold-storage interests were discussed in detail.

One of the principal objects of the meeting was to decide on the place and time for holding the third international congress of refrigeration, which, as noted above, will be held in this country by special invitation of the United States Government. A spirited contest developed between New York and Chicago for the honor of entertaining the foreign delegates and American representatives of the coming congress. The discussion of this subject was carried over until the following day, when, after repeated ballots on motions and amendments to motions, it was finally decided to hold the international meeting in Chicago. The plan as tentatively outlined by the Chicago Association of Commerce, in connection with the executive committee of the American Association of Refrigeration, is to have the foreign delegates gather at New York, leaving that city September 14, 1913, for Washington, where, on September 15, the opening exercises will be held and participated in by the President of the United States. After the exercises at Washington have been completed the delegates will be taken on special trains to Chicago, where the business sessions of the congress will be held and where the delegates will have the opportunity of inspecting the application of refrigeration to the enormous packing industries of the city.

Following the Chicago meeting it is proposed to have the special trains return East by way of Niagara Falls, holding the closing exercises in New York City.

Officers of the American association for the following year were elected as follows: William J. Rushton, president, Birmingham, Ala.; vice-presidents, E. O. McCormiek, San Francisco, Cal.; Thomas Shipley, York, Penn.; Jacob Ruppert, New York City; Homer McDaniel, Cleveland, O.; Joseph Alderdiee, Indianapolis, Ind.; George L. Flanders, New York City; Roderick H. Taft, St. Louis, Mo. John S. Field, Chicago, was elected treasurer and J. F. Nickerson, editor *Ice and Refrigeration*, Chicago, was reëlected secretary.

An organization to take care of the arrangements for the coming international congress was perfected and two general officers were elected as follows: J. B. Forgan, First National Bank, Chicago, treasurer-general, and J. F. Nickerson, Chicago, secretary-general. Election of the other officers was left until later action by the executive committee.

N. E. L. A. Convention

The executive committee of the National Electric Light Association held on May 11, at the New York offices, a final meeting before the coming convention. The report of the secretary showed a flourishing state of affairs. Over 1800 new members were admitted, showing the gross gain since the last meeting about two months ago, and a net gain of over 1600.

Although the convention was three weeks off, it was stated that the registration had already reached about 1750, which would indicate an actual attendance of at least 3500 to 4000. Additional facilities for the meeting have been secured in the Engineering Societies building which will assist in distributing the throng over several floors. On the ground floor the ingenious idea has been adopted of supplementing the foyer by inclosing the entire large driveway around the building so that the members can also sit and lounge in the open air. The three largest meeting rooms will be devoted to the regular sessions and on the floor above another meeting room has

AMERICAN ASSOCIATION OF REFRIGERATION IN SESSION AT LA SALLE HOTEL, CHICAGO

been appropriated as headquarters for the New England section, the Eastern New York section, the Pennsylvania section, the Sons of Jove and any other affiliated or auxiliary body applying for such accommodation. The exhibition committee will also have its headquarters on this floor and the subcommittee on theaters, which will distribute the tickets for the three theaters which have been engaged for Thursday evening of the convention week, May 29 to June 2.

The Public Policy meeting is to be held on Wednesday evening, May 31, at the New theater, when Secretary Nagel will represent President Taft and deliver an address. The report will be presented by Past President Samuel Insull, of Chicago.

The baseball game will take place on Wednesday afternoon at the baseball grounds in Brooklyn, which are very accessible from headquarters; the competing teams will be those of the Brooklyn and Philadelphia companies.

The regular meetings have been arranged to occupy some sixteen sessions extending throughout Tuesday, Wednesday, Thursday and Friday.

A Memorandum Booklet

Charles C. Moore & Co., engineers, of San Francisco, Cal., are getting out a memorandum booklet for distribution among the engineering fraternity and managers of plants. The book, 3¼x7 inches, is bound in black leather, with a pocket on the inner side of either cover, and the pages are perforated into five squares, each of which is large enough to jot down a specific note or engagement. As soon as the matter has been attended to, the square may be torn out regardless of any of the others. This in itself is a great convenience as it saves the trouble of wading through a miscellaneous collection of notes of no current value to find what is wanted, and for the same reason the live material is more readily found. When the pages are all used, new inserts, as they are called, may be obtained by application to the nearest branch office of the company.

The A. O. S. E. to Meet at Philadelphia

The twenty-fifth annual convention of the American Order of Steam Engineers will convene at Philadelphia from June 5 to 10. Every available foot of floor space in the large auditorium of Odd Fellows' Temple has been assigned to the various firms in the engineering line for the display of their goods and appliances. The committee are putting forth their best efforts in devising ways and means to accommodate the many late applicants, who are now anxious to secure exhibit space, and it is feared that it will be impossible to locate all of them. The several sessions of the delegates will be held in an upper hall in the same building.

The dealers and engineers, and, in fact, everybody interested in the power-plant industry in Philadelphia and vicinity, have been invited to attend the convention, and there is an assurance that the exhibit hall will be well patronized at all times.

An excellent program of entertainment has been arranged, and taken altogether, the outlook favors a most successful meeting.

A Correction

In the May 9 issue, page 718, the word Keeler, instead of Kellogg, was inadvertently used in specifying the make of the 175-foot radial-brick chimney for the municipal pumping and power plant of Orange, N. J.

PERSONAL

Gordon C. Keith, managing editor of *Canadian Machinery, The Power House* and *Canadian Foundryman,* has resigned to join the editorial staff of *The Canadian Manufacturer.*

E. Heinrich, M. E., who, with Doctor Junge, has been writing a series of articles for POWER upon "The Steam Turbine," has given up his position upon the designing staff of the Fore River Ship Building Company to fulfil an assignment of two years in the research department of the technical high school at Stuttgart, Germany, under Doctor von Bach.

John F. Wallace, formerly chief engineer of the Panama canal, who retired after inaugurating the American work on the canal and afterward designed the new Chicago & Northwestern passenger terminal at Chicago, which has just been completed at a cost of $25,000,000, has assumed active charge as president of Westinghouse, Church, Kerr & Co., replacing H. H. Westinghouse upon the latter's recommendation to the board of directors.

SOCIETY NOTES

At the regular monthly meeting of the Internal Combustion Engineers, of Chicago, held on the evening of May 12, at Fraternity halls, 19 West Adams street, officers for the following year were elected as follows: Charles Kratsch, president; Wallace V. Pye, secretary, and I. J. Babcock, treasurer.

On Thursday evening, May 11, Branch No. 1, District No. 2 of the Institute of Operating Engineers, New York City, held its regular monthly meeting, at which F. L. Johnson presented his paper on the "Needs for Industrial Education." The paper drew forth considerable comment from the members and the discussion was both lively and interesting. About 50 members of the branch were present and the interest in the Institute seems to be growing constantly.

On Saturday evening, April 22, the seventh bimonthly meeting of the Colonel Goethals branch was held. A paper on the "Theory and Operation of Hydraulic Laws" was given by R. V. Madden and a short paper on "Water in Pipes" was delivered by W. R. Vernon.

On account of the interest manifested on the subject of "Fuel Testing," considered at the meeting of the American Society of Mechanical Engineers in Philadelphia on April 22, when a paper by J. C. Parker of that city on the "Work of the United States Fuel Testing Station" was presented, the meeting on June 3 in that city will be given up to further discussion of the same topic. The Engineers Club, of Philadelphia, will cooperate in the meeting.

The annual convention of the New Jersey State Association of the National Association of Stationary Engineers, will be held at Newark, N. J., June 2, 3 and 4. The several meetings of the delegates will take place in the New Auditorium, on Orange street, and in the main hall of the same building the mechanical exhibit will be shown. On Saturday evening, June 3, there will be a banquet at the Continental hotel, and several prominent speakers will address the diners.

NEW PUBLICATIONS

ELECTRIC POWER PLANT ENGINEERING. By J. Weingreen. Published by the McGraw-Hill Book Company, New York, 1910. Cloth; 431 pages, 6x9 inches; 291 illustrations; numerous tables. Price, $5.

This book was written to fill the want of a treatise upon present practice in the electrical equipment of power plants. The subject is divided into two groups: direct-current apparatus and alternating-current apparatus. In the first group are taken up dynamos, synchronous converters, mercury rectifiers, storage batteries, direct-current motors and switchboards. The second group deals especially with high-tension transmission, switching equipment and remote control. In each case the standard types of apparatus are illustrated and explained, various types of construction are shown, and complete wiring diagrams are submitted. A considerable portion of the text is devoted to illustrations of a number of large central stations and substations now in actual operation.

The book is in no sense a textbook and does not go into any theoretical considerations of electricity. On the other hand, it represents present power-plant practice and as such should prove of great service to consulting and constructing engineers.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

NEW YORK University held an interesting celebration on May 5. The event was the 100th anniversary of the birth of John William Draper, once a professor of chemistry in the university, and widely known as the "Father of Modern Photography."

This event is of special interest to all of us because it was Professor Draper who made snapshot photography possible.

Before his discovery photography was practically a studio process, for if used out of doors it required long exposure, steady pose and most favorable light conditions. Today snap shots have increased the number of photographs in the ratio of 1000 to 1. They can be taken at any time, day or night, and the field has been extended wonderfully by invention.

Without Professor Draper's discovery the later invention of making plates by the halftone process could not have become possible commercially.

Think what this development of the halftone cut means to you and to every other reader of our selling-section news.

Every manufacturer aims to show you frankly and plainly just how his product appears.

You are no longer dependent on the drawing from the skilful, but too often prejudiced, hand of an artist at from 50 to 100 times the cost of a photograph. You see things as the camera sees them.

An artist once tried to flatter Oliver Cromwell by painting his portrait and leaving out the wart on his nose—Cromwell vented the vials of his wrath on him as a reward. "Paint me as I am," said he.

The advertiser in our selling section today is saying almost in Cromwell's words, "Paint things as they are." Everything possible is done to make these pages worth your careful attention.

Catalogs and booklets are published, often at great expense, and these fine samples of the printer's and the engraver's art are distributed to you absolutely free.

Unconsciously you have formed the habit of judging the character of the manufacturer and his product by his advertising—space, copy and catalogs.

Copy and the display of cuts have advanced to such a point in our selling section that these pages of POWER are a moving picture of progress in the manufacture of Power Plant devices.

Each ad is telling its part of the story—the latest news from the men at the front who are making your job one of greater importance every day.

Manufacturers are presenting to you here, from week to week, their straightforward and illustrated arguments. They appeal to your eye by their cuts and to your mind by newsy and interesting copy.

These pages, with all the thought and money invested in them, are doing their share of the world's work. They are as profitable to the buyer as to the manufacturer. The advertiser is willing to invest his money to buy space in which to tell you about his product. This certainly proves his belief in what he has to say and commands your confidence in his words.

BUSINESS ITEMS

The American Steam Packing Company has removed to more commodious quarters at 10 and 12 High street, Boston, Mass.; its former address was 51 High street.

The Bradford Dyeing Association, of Bradford, England, a concern that operates 46 mills with a capital of $150,000,000, and has 26,000 employees, is building a large plant at Niantic, R. I., and has ordered for this plant 2000-horsepower return tubular boilers from the Bigelow Company, New Haven, Conn. The United States Finishing Company, Pawtucket, R. I., has also ordered 1200-horsepower return tubular boilers from the Bigelow company.

NEW EQUIPMENT

Whitefield, N. H., will erect a new power house.

Morganton, N. C., voted $35,000 for waterworks.

The Prince Rupert (B. C.) Power Company cost $300,000.

Marietta, Ga., voted $20,000 bonds for electric-light plant.

Melville, Sask., will install a complete new electric-lighting plant.

John A. Harris, Lawrence, Mass., will install refrigerating plant.

The Crystal Paper Company, Amanda, Ohio, will build a new power plant.

Thos. Hersum & Co., New Bedford, Mass., will install a boiler and engine.

The Nortonville (Ky.) Traction Company will erect an electric-light plant.

The Lowell Gas Light Company, Lowell, Mass., will build a new power house.

The plant of the Milton (Del.) Electric Light Company was destroyed by fire.

Renfrew, Ont., will spend $125,000 for new electrical equipment for its power house.

The plant of the Crandall Packing Company, Palmyra, N. Y., was destroyed by fire.

The Lowell (Mass.) Gas Light Company will erect a new power house to cost $200,000.

The Rodenhausen Excelsior Wagon Works, Philadelphia, Penn., will enlarge its power plant.

John J. Hurley, Revere Beach, Mass., is in the market for a 10-horsepower, 3-phase motor.

The Grafton, Fairmont & Clarksburg Railway will erect a power house at Grafton, W. Va.

The town council, Milton, Del., is to appropriate money for installing waterworks system.

Baker, Ore., has voted $185,000 bonds for municipal lighting plant and waterworks system.

The Hydro Electric Company, Bodie, Cal., will rebuild its power plant recently destroyed.

The Ennis (Tex.) Ice, Light and Power Company will install additional ice machinery.

The pumping plant of the Seattle (Wash.) Brewing and Malting Company was destroyed by fire.

The Central Maine Power Company will build a new steam electric plant at Farmingdale, Me.

Toronto, Ont., will receive bids up to June 6, for vertical electrically driven pumps, motors, etc.

Telling Brothers Company, Cleveland, Ohio, will build an ice and ice-cream plant at Youngstown.

The Mattatuck Manufacturing Company, Waterbury, Conn., is preparing to build a new power house.

E. R. Godfrey & Sons, Milwaukee, Wis., are having plans prepared for a $100,000 cold-storage plant.

Cleveland, Ohio, will newly equip the old Division Street pumping station at a cost of about $300,000.

Wetumpka, Okal., voted to issue $10,000 bonds for extending its electric-light system and waterworks.

J. A. Jones, Canton, Ohio, has been granted a franchise and will guild a gas plant at Pocatello, Idaho.

The Cove Power Company, Princeville, Ore., will build a power plant on Crooked river, near Culver, Ore.

Elgin, Ore., will make extensive improvements in its water system. J. R. Thompson, Portland, engineer.

Williamson Brothers are erecting a new power house at Moyer and Adams streets, Philadelphia, Penn.

The New York, New Haven & Hartford Railroad will erect an addition to its power house at Greenwich, Conn.

The Great Western Power Company, San Francisco, Cal., has been granted a light and power franchise at Auburn.

The packing plant of the United States Asbestos Works, Manheim, Penn., was damaged by fire. Loss, $25,000.

Power-plant equipment will be required for the new 12-story building to be erected by J. Gevurtz & Son, Portland, Ore.

The Citizens Electric Light, Heat and Power Company, of Yonkers, N. Y., has about decided on site for a power plant.

The Philadelphia (Penn.) Electric Company has purchased site at Devereaux and Milner streets for a power house.

M. W. Fockler, of Winona, Minn., will erect a plant to supply power to Endicott, Winona, Minn., and La Crosse, Wis.

The Belber Trunk and Bag Company will erect a one-story power plant at Hancock and Turner streets, Philadelphia, Penn.

The Acme Tea Company will build a bread plant, including power house, at Twenty-fifth and York streets, Philadelphia, Penn.

Swift & Co. are erecting a two-story building on East Market street, Buffalo, N. Y., to be equipped as a cold-storage plant, etc.

Power-plant equipment will be needed for the new building to be erected by the Madison Square Building Company, Seattle, Wash.

The Pacific Coast Condensed Milk Company, Seattle, Wash., will erect a plant at Chilton, Wis. Eight boilers will be installed.

The Indianapolis (Ind.) Water Company will make improvements at the Riverside pumping station at a cost of over $10,000.

The Modern Gas Light and Power Company, Montreal, Canada, of which P. G. Majean is the head, will build a large new plant.

The Butzbach Fruit and Cold Storage Company, South Bend, Ind., a new concern capitalized at $300,000, will erect a six-story building.

The Pacific Fruit Express Company, Portland, Ore., will build a large ice plant at Nampa, Idaho. Pre-cooling machinery will be installed.

The Pacific Fruit Cooling and Vaporizing Company, Lodi, Cal., will erect a pre-cooling plant. Heavy refrigerating machinery will be installed.

The Home Telephone Company, Los Angeles, Cal., is planning the erection of a power plant and distributing station at South Pasadena.

NEW CATALOGS

The Bruce-Macbeth Engine Company, Cleveland, Ohio. Catalog. Vertical multi-cylinder gas engines. Illustrated, 32 pages, 6½x10 inches.

Crandall Packing Company, Palmyra, N. Y. Catalog No. 6. Fibrous, semi-metallic and metallic packings. Illustrated, 144 pages, 5x7 inches.

Bates Machine Company, Joliet, Ill. Catalog. Cookson cast-iron heaters and receivers with cut-out valves. Illustrated, 24 pages, 6x9 inches.

The Kelly & Jones Company, Greensburg, Penn. Catalog K. Cast-iron pipe fittings, valves, lubricators, etc. Illustrated, 454 pages, 5x7½ inches.

B. F. Sturtevant Company, Hyde Park, Mass. Bulletin No. 187. "Economical Fire Room Methods," by F. R. Low. Illustrated, 24 pages, 6½x9 inches.

Ideal Electric and Manufacturing Company, Mansfield, Ohio. Bulletin No. 1031. Squirrel cage polyphase induction motors. Illustrated, 12 pages, 8x10½ inches.

John J. Ridgway, 207 Fulton street, New York. Pamphlet. "How to Buy Conveyor Belts." Pamphlet. "Use and Abuse of Conveyor Belts." 14 pages, 6x8½ inches.

American District Steam Company, Lockport, N. Y. Bulletin No. 120. "Some of the Factors that Effect the Cost of Generating and Distributing Steam for Heating," by Chas. R. Bishop.

The Deane Steam Pump Company, 115 Broadway, New York. Bulletin D201. Single steam pumps. Illustrated, 44 pages, 6x9 inches. Bulletin D 216. Express pumps. Illustrated, 8 pages, 6x9 inches.

The Griscom-Spencer Company, 90 West street, New York. Catalog No. 301. Reilly multicoil evaporators. Illustrated, 12 pages, 6x9 inches. Catalog No. 401. G-S evaporative ammonia condenser. Illustrated, 4 pages, 6x9 inches.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ENGINEERS to solicit orders for the Rolin patent adjustable grate bar. Apply Standard Grate Co., Heed Bldg., Philadelphia, Penn.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

LOCAL SALESMAN with established trade in packing, oils or grease can obtain good side line with no samples. Address "Manufacturer," Box 443, POWER.

WANTED—Competent high pressure boiler salesman; will give the right man an opportunity of investing in a business established for forty years. Address Box 444, POWER.

SALESMAN calling at power plants to handle as a side line superior packing for steam, different from the rest and better. Nugget Packing Co., 185 Summer St., Boston, Mass.

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

POSITION OPEN—Water wheel chief engineer; thoroughly competent designer and constructor to take full charge of latest up

to date Francis turbine wheels and governors; applicant must have extended experience; give full particulars. Box 441, POWER.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

TECHNICAL MAN, 34, married, 13 years' experience, power, light, telephone, construction and operation, want connection as electrical engineer or superintendent, light or power plant; good business ability; prefer West or South; would consider foreign country. Box 433, POWER.

WANTED—Position as factory engineer or superintendent of power, where gas engines are used; experienced with central station, mine, mill and factory equipment, turbines, automatic, and large and small gas engines, alternating- and direct-current generators, switchboards, wiring, motors and lighting and all machinery in modern mills and factories; now open. Box 445, POWER.

GAS ENGINEER to take charge of producer gas engine plants, familiar with the erecting and operating of large horizontal and vertical gas engines; suction and pressure producers; low and high grade fuel; indicating and fuel analyses; mechanic and machinist; now in charge of 2000 horsepower plant in Mexico; age 37; willing to go to any place. Box 440, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

The Vulcan Soot Cleaner offers an exceptional opportunity for power specialty salesmen. For further particulars address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

SUBSCRIBE NOW for the 1911 issue of the Stationary Engineers' Directory of the city of Philadelphia; $5 per copy. Mail checks to Stationary Engineers' Club, 1108 Arch street, Philadelphia, Penn.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—One Crosby indicator; springs, forty and sixty; two single cocks, $28; with Victor reducing wheel, $35. J. W. Blakeslee, Du Quoin, Ill.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—50 horsepower horizontal tube Bigelow boiler, 35 horsepower Greenfield vertical engine, both in good condition; will sell together or separately. General Acoustic Company, Jamaica, N. Y.

FOR SALE—Two used horizontal tubular boilers, 66 inches diameter by 16 feet long; 54 four-inch tubes; 90 pounds pressure allowed by insurance company; in good condition. Herman Behr & Co., Inc., 45 Tiffany Place, Brooklyn, N. Y.

ONE PATENT Berry boiler; capacity, 100 horsepower, good for 125 pounds working pressure; free from scale and recently retubed and is in A-1 condition; now in use. Henry H. Sheip Mfg. Co., Columbia Ave. and 6th St., Philadelphia, Pa.

FOR SALE—320 feet 2 7/16-inch shafting, mostly in 20-foot lengths; 34 hangers, 21x 2 7/16 and two hangers, 19x2 7/16; two hangers, 16x2 7/16; six flange couplings fitted. Address "Shaftings," Care Morse International Agency, 449 4th Ave., New York.

FOR SALE—One compound Reynolds Corliss engine, high pressure cylinder 32 inches, low pressure 60 inches, stroke 60, 1200 horsepower at 100 pounds pressure, 70 revolutions per minute, flywheel diameter 20 feet, face 56 inches, built in sections; shaft length 16 feet diameter in wheel 16 inches, single eccentric. Box 434, POWER.

FOR SALE—11"x15" Ames steam engine, 8"x20" Rollins, 10½"x11" Armington & Sims high speed, 10"x20" box bed Watertown, upright Westinghouse 25 horsepower, 13"x34" Brown, 16"x38" Rollins, 300-horsepower Harrisburg high speed compound, 600-horsepower McIntosh & Seymour tandem compound, 650-horsepower Geo. H. Corliss compound; low price. J. F. Foster, 166 Devonshire St., Boston, Mass.

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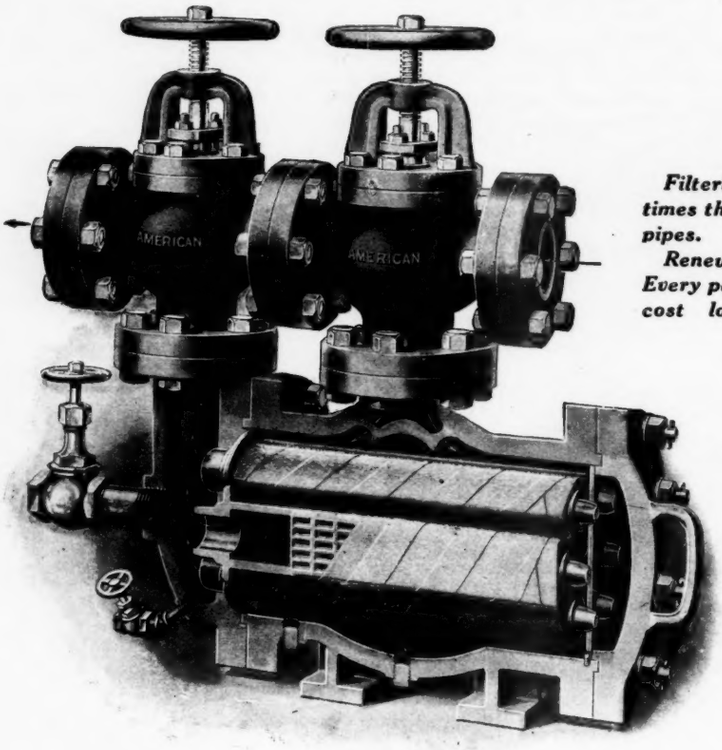

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The American H_2O Grease Extracting Feed Water Filter

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It removes every particle of oil or grease.

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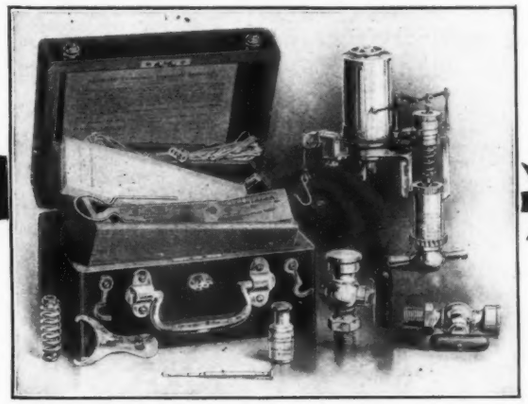

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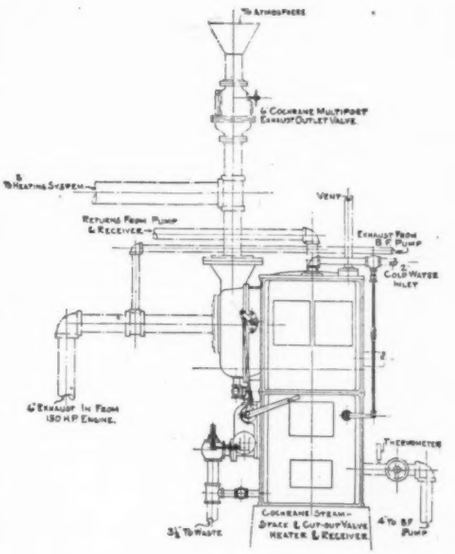
Saving A Ton Of Coal A Day In A 150 H. P. Plant

A gentleman who at our request recently visited a wall paper company's power plant, in which we some time ago installed a **COCHRANE STEAM-STACK AND CUT-OUT VALVE HEATER AND RECEIVER** in connection with an exhaust steam heating system, writes us as follows:

> *"Mr. ———— states that he has saved over a ton of coal a day, heats the old building and the new building, measuring 300 ft. by 50 ft., and three stories high, saving him a new boiler, and the heater has paid for itself to date."*



If you can save a ton of coal a day by applying the exhaust steam from a 150 H. P. engine to heating the plant, how much could you save in your plant? Figure it out.

A ton of coal a day, you see, is something like **500** Dollars a year, or more if you are using hard coal. Isn't that worth going after?

The **COCHRANE STEAM-STACK AND CUT-OUT VALVE HEATER AND RECEIVER** not only reheats the condensed returns, and supplements them with raw cold water to make up the boiler feed, but it also purifies of oil all the exhaust steam delivered by the engine, as shown in the accompanying diagram, so that it can safely be passed to the heating and drying coils, and will not foul the latter with grease, and the condensed returns can be brought back and used for boiler feeding, since the steam has been entirely purified of oil by its passage through the extra large separator attached to and forming a part of the heater.

If it is necessary to operate the heating system 24 hours per day, that need not interfere with occasionally cleaning the heater, since valves are incorporated between the separator and the heater, and between the trap which drains the separator and the heater, so that the latter can be cut out of service for cleaning or inspection while the trap and separator remain in service. These valves are connected together by a **FOOL-PROOF** valve gear, so that you cannot turn one valve without turning the other; moreover, while you are opening the heater you can take the handle off, so that no one can turn steam in on you.

If you are interested in the utilization of exhaust steam for heating or drying purposes, you should read our "*Exhaust Steam Heating Encyclopedia*," which describes all the commercial exhaust steam heating systems. We shall be pleased to send you a copy of this book if *you* will kindly give

(1) Your address and the name of the firm with which you are connected, also
(2) The horse-power capacity of the plant and
(3) The present temperature and method of heating your boiler feed water.

HARRISON SAFETY BOILER WORKS

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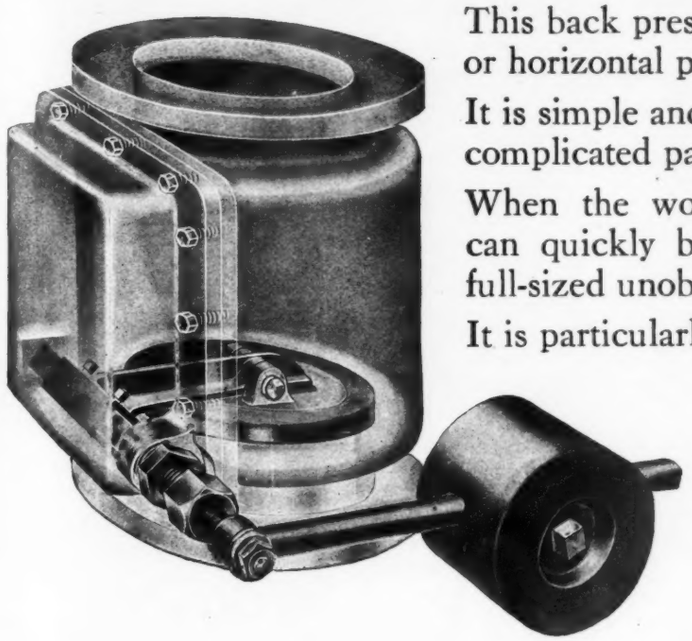
Excelsior Straightway Back Pressure Valve



This back pressure valve can be used in a vertical or horizontal position or at any desired angle.

It is simple and practical in construction; has no complicated parts of any kind.

When the working parts are not needed they can quickly be thrown into the cover, leaving a full-sized unobstructed passage through the valve.

It is particularly suited for exhaust steam heating because it has no dashpots, guides or levers. It can also be used as a relief or free exhaust valve for condensing engines.

It is fitted with the Jenkins Disc which can easily be replaced if necessary.

The Jenkins Diamond Steam Trap

The ideal trap for places where only a moderate amount of condensation exists.

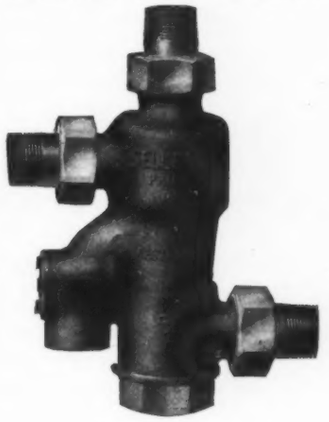
Automatic in action; absolutely reliable; it removes the condensation without wasting any steam.

It is especially adapted for use for steam heating coils, for steam jackets and kettles, and for heaters.

It will remain open as long as water escapes and close as soon as steam strikes the plug.

Sellers Restarting Injector

Has a wide range of capacities; lifts the water promptly with hot or cold water. It restarts instantly after a temporary interruption of the steam or water supply.



It is a well-made injector, strong and durable. The joints are screwed and the tubes do not depend on the pressure of steam to hold them in place—no leakage at the shoulder can consequently take place.

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The "Eureka" Square Deal

Published every other week in the Interests of Honesty in the Packing Business.

Vol. I. **By James L. Robertson.** No. IX

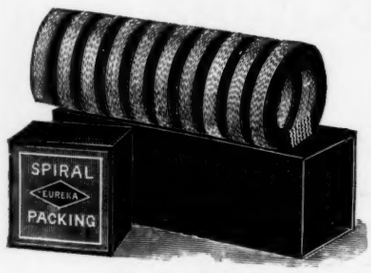
How Can A Grafter Be "Adviser To The Management"?

I had something to say in the last issue of the Square Deal about improved conditions and progress in power plant engineering.

In the same issue of POWER there appeared a letter on page 737 on the identical subject.

The writer of it clearly drew a picture of the contrast between the conditions existing not many years ago and those of today and he showed that the engineer is becoming the "adviser of the management."

That is some position to hold; it is more than a job—it's the beginning of a *career*.



Eureka Spiral

Every manufacturer is more interested in the production of the article he is marketing than he is in the production of the power that runs his machinery. That is natural. He is, by training, a specialist in other lines of work. But back in the engine room is a man whose whole business is the generation and transmission of power. He, too, is a specialist, with a big S. It is his business to know how to produce and transmit power at the least cost for the best results. His is a place of responsibility. And not the least of it is his position as "adviser to the management."

The whole tendency of steam and electrical engineering is toward bigger things, greater responsibilities, more scientific management and *better men*.

Don't you see the possibilities of the profession? Don't you realize that this recognition of what constitutes a good engineer means greater remuneration?

That is one side of the question.

On the other hand is a small group of men who are actually able to hold back, to a certain extent, the progress of your profession.

They are the "grafters" who are giving you and other believers in square business a bad reputation—making all employers believe that nearly all engineers are in the same class.

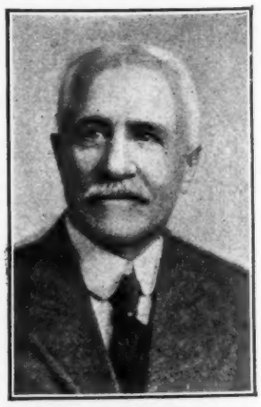
If you, by dint of hard work and self-education, have fitted yourself for the position of "adviser to the management," does it seem fair to be handicapped by the underhand practices of grafting engineers and graft-offering manufacturers?

You know that I am running this "graft" campaign because I found **Eureka Packing** being replaced in many instances by inferior packings that carried a bribe with them.

Now, I realize fully that packing is only an engine room accessory, but I consider it an important one. Whether it be important or not does not interfere with the fact that graft is not confined to packing, but spreads to nearly all supplies used.

Which means that worthless products are finding their way into power plants and destroying what the engineer in charge should be most careful of—the economical and efficient running of his plant.

Eureka Packing is that kind of packing which will prove a source of efficiency, economy and satisfaction to the engineer and the owner.



JAMES L. ROBERTSON

It is sold through reputable dealers all over the country, and it is sold strictly on a non-bribe basis. There's nothing "in it" for the grafter—there's one hundred per cent. packing value in it for the fair and square, above-board, self-respecting engineer.

I believe thoroughly in the fairness and uprightness of my engineer friends. I know that they form the great bulk of the profession. I know that they want to do business on a fair and square basis—and by that token they'll buy a packing that is *good* packing minus "graft."

You'll find it at your dealer's. If he doesn't carry it, send to us direct. We'll pay freight on 10 lbs. and over east or south of Omaha. We make 39 varieties for all purposes and the line comprises all styles and shapes.

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